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Factors associated with immunisation coverage for the childhood immunisation programme in New Zealand: 1999 to 2012

Nikki (Nicola) Mary Turner

A thesis submitted in partial fulfilment of the requirements for the degree of MD
The University of Auckland, 2014

Abstract

Introduction

National childhood immunisation programmes are some of the most cost-effective activities in healthcare. Reductions in morbidity and mortality from vaccine-preventable diseases (VPDs) can be maximised if universal high immunisation coverage and timeliness of delivery is achieved with all the schedule vaccines. Despite this knowledge, New Zealand (NZ) traditionally has had poor immunisation coverage for its childhood programme; with significant equity gaps particularly for children from Māori and Pacific Island ethnic groups.

Aims

To document and analyse the reasons behind the improvement in childhood immunisation coverage and reduction in socioeconomic and ethnic equity gaps that have been seen since 2000.

Methods

A range of studies were conducted from 2000 to 2012 with NZ parents, the media, and primary care providers focused on identifying the major factors for low immunisation coverage and poor timeliness of delivery and the positive factors where high immunisation rates were obtained. Factors identified from these studies were then used to advise policy and design intervention studies to improve immunisation coverage rates.

Findings

NZ factors associated with low immunisation coverage and poor timeliness of delivery include parental knowledge and attitudes, environmental issues, media drivers, health professional knowledge and attitudes, and primary care systems. The most significant factors identified were maternal knowledge and experience in the antenatal period, socioeconomic, ethnicity, age of registration with a general practice, practice systems, and staff support, knowledge, and education. Multicomponent interventions particularly focused on general practice systems and providers are effective.

Conclusions

Prioritising and goal setting at the national, district, and provider levels, having the right tools to measure coverage, feedback loops, public reporting, and supporting an educated and confident provider workforce appear to have underpinned the improvement in childhood immunisation coverage in NZ.

The components that need to be in place to make this happen include a mixture of factors from the broader political and health service setting, provider systems and characteristics, factors associated with the families and their children, and other environmental issues such as the general community awareness and communication as driven via traditional and social media.

Acknowledgements

"Coming together is a beginning; keeping together is progress; working together is success" - Henry Ford

This work is not mine alone and it would never have been possible alone. This is a team effort.

The Immunisation Advisory Centre (IMAC) was created to support and improve immunisation service delivery. In the early development of IMAC, it became apparent that we would require local research to understand the NZ context and assist in giving recommendations and direction to support NZ strategy. The questions to answer and the networks necessary to support the research delivery have arisen through working with the IMAC staff and our networks of immunisation coordinators and providers, particularly practice nurses and general practitioners throughout NZ. The engagement in research and support to continue was only possible due to the commitment, energy, and enthusiasm of all the IMAC team and our colleagues at Auckland Uniservices and the Department of General Practice and Primary Care. We have also been well supported by the MoH and many national and local organisations who have all been part of the commitment to improving immunisation coverage in NZ.

I would have not been able to undertake this academic work without the encouragement and mentorship of Associate Professor Cameron Grant and Professor Felicity Goodyear-Smith. To you both, I owe a huge thank you for introducing and supporting me into research. Felicity as my primary supervisor has remained committed to encouraging, guiding and supporting me, no matter how busy in her own endeavours. To my co-supervisor, work partner and closest friend Dr Helen Petousis-Harris, you have walked with me on every step of this path and I thank you for always being there for me and believing this would be possible.

This work was enabled via a range of funding sources. Time and funding support were provided from the Immunisation Advisory Centre, Auckland Uniservices. Various projects were funded by the Health Research Council. Other sources of funding included the Ministry of Health, DHBNZ and GlaxoSmithKline. Also my very grateful thanks for the generous support given for formatting and layout of this document go to Vanessa Nathan and Karen Reeves.

I wish to thank the many co-authors who have contributed to this research, and all those involved in supporting the immunisation programme in NZ. This is a unique example of utilising our experience in service delivery, combined with practical research to assist in improving an important child health outcome: An outcome of which we can all be proud.

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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Turner, N.Baker, M., Carr,J., Mansoor, O., Improving immunisation coverage: what needs to be done. New Zealand Public Health Report, 2000. 7(3/4): 11-14.

Nature of contribution by PhD candidate	Lead author, contributed to literature review, planning, analysis, discussion and manuscript development
Extent of contribution by PhD candidate (%)	60%

CO-AUTHORS

Name	Nature of Contribution
Michael Baker	contributed to analysis, discussion and manuscript development
Julia Carr	contributed to analysis, discussion and manuscript development
Osman Mansoor	contributed to analysis, discussion and manuscript development

Certification by Co-Authors

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Grant, C.C., Turner, N., Jones, R., Eliminating ethnic disparities in health through immunisation: New Zealand's chance to earn global respect. NZMJ editorial 13 March 2009 22: 1291-4

Nature of contribution by PhD candidate	contributed to analysis, discussion and manuscript development
Extent of contribution by PhD candidate (%)	20%

CO-AUTHORS

Name	Nature of Contribution
Cameron Grant	Lead author - developed the manuscipt, including literature review, analysis and discussion
Rhys Jones	contributed to the discussion and manuscript development

Certification by Co-Authors

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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Petousis-Harris, H.,Turner, N., Examining immunisation in New Zealand. Vaccin. Pract, 2009. 2(4): 10-11.

Nature of contribution by PhD candidate	contributed to the analysis, discussion and manuscript development
Extent of contribution by PhD candidate (%)	40%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Lead author on the analysis , discussion and manuscript development

Certification by Co-Authors

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Turner, N., Hounsell, D.,Robinson, E., Tai, A.,Whittle, N., Uptake of postnatal services for mothers of newborn babies up to eight weeks of age. The New Zealand Medical Journal, 1999. 112(1098): 395 - 400

Nature of contribution by PhD candidate	Lead author
Extent of contribution by PhD candidate (%)	80%

CO-AUTHORS

Name	**Nature of Contribution**
Doreen Hounsell	contributed to concept, discussion and paper writing. (now deceased)
Elizabeth Robinson	contributed to analysis
Anna Tai	contributed to conducting the study and analysis
Nicola Whittle	contributed to conducting the study and analysis

Certification by Co-Authors

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Anna Tai	Anna Tai	6/09/2013
Elizabeth Robinson	E.M.	6/09/2013
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Petousis-Harris, H., Turner, N., Kerse, N., New Zealand mothers' knowledge of and attitudes towards immunisation. New Zealand Family Physician, 2002. 29(4): 240-246.

Nature of contribution by PhD candidate	major contribution to concept, design, discussion, analysis, and paper writing
Extent of contribution by PhD candidate (%)	40%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Lead author, involved from concept right through to completion and paper writing
Ngaire Kerse	contribution to analysis, discussion and paper writing

Certification by Co-Authors

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Petousis-Harris, H., Goodyear-Smith, F., Godinet, S., Turner, N., Barriers to childhood immunisation among New Zealand mothers. New Zealand Family Physician, 2002. 29(6): 396-401

Nature of contribution by PhD candidate	Contributed to the concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	30%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Lead author, contributed to the concept, design, analysis, discussion and paper writing
Felicity Goodyear-Smith	contributed to design ,analysis, discussion and paper writing
Sue Godinet	conducted the study, contributed to analysis and paper writing

Certification by Co-Authors

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Sue Godinet	TNS	13/09/2014
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Petousis-Harris, H., Boyd, E., Turner, N., Immunisation education in the antenatal period. New Zealand Family Physician, 2004. 31(5): 303-306.

Nature of contribution by PhD candidate	contributed to concept , design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	40%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Primary author, contributed to concept,design, analysis, discussion and paper writing
Elaine Boyd	Contributed to concept, conducting study, discussion and paper writing

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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Wroe, A.L.,Turner, N., Salkovskis, P.M. Understanding and predicting parental decisions about early childhood immunizations. Health Psychology, 2004. 23(1): p. 33

Nature of contribution by PhD candidate	contributed to concept, design, discussion, analysis and paper writing
Extent of contribution by PhD candidate (%)	20%

CO-AUTHORS

Name	Nature of Contribution
Abigail Wroe	Lead author: conceived, designed and conducted the study, analysed results and wrote up the findings
Paul Salkowski	Contributed to design, analysis, discussion and paper writing

Certification by Co-Authors

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Paul Salkowski		21/08/2013
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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Wroe, A.L., Turner, N., Owens, R.G., Evaluation of a decision-making aid for parents regarding childhood immunizations. Health psychology: official journal of the Division of Health Psychology, American Psychological Association, 2005. 24(6): 539.

Nature of contribution by PhD candidate	contributed to concept, design, discussion, analysis and paper writing
Extent of contribution by PhD candidate (%)	30%

CO-AUTHORS

Name	Nature of Contribution
Abigail Wroe	Lead author, conceived, designed and conducted the study,analysed and wrote up the study
Glynn. Owens	Contributed to analysis, discussion and paper writing

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R Glynn Owens		Click here
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Mueller, S.,Exeter,D., Petousis-Harris H.,Turner N.,O'Sullivan D., Buck, C., Measuring disparities in immunisation coverage among children in New Zealand. Health & Place, 2012;18(6): 1217-1223.

Nature of contribution by PhD candidate	contributed to concept, design, analysis and paper writing
Extent of contribution by PhD candidate (%)	10%

CO-AUTHORS

Name	Nature of Contribution
Steffen Mueller	Lead author, conceived, designed, undertook the full study analysis, wrote the discussion and paper
Daniel Exeter	Primary supervisor, gurantor, contributed to the design, conduction of the study, analysis and paper writing
David O"Sullivan	contributed to data analysis and paper writing
Christoph Buck	contributed to discussion and paper writing

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Steffen Mueller		27/08/2013
Daniel Exeter		5/08/2013
Helen Petousis-Harris		25/07/2013
David O'Sullivan		28/08/2013
Christoph Buck		27/08/2013

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Goodyear-Smith, F., Petousis-Harris H., VanLaar, C., Ram, S.,Turner, N., Immunization in the print media—Perspectives presented by the press. Journal of Health Communication, 2007. 12(8): 759-770.

Nature of contribution by PhD candidate	Contributed to concept design, conducting the study, discussion and manuscript development
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, contributed to design, conducting the study, analysis, discussion and manuscript development
Helen Petousis-Harris	contributed to design, conducting the study, analysis, discussion and manuscript devleopment
Colleen VanLaar	major contributor to conducting the study and analysis
Stephen Ram	major contributor to conducting the study, contributed to analysis and manuscript development

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Felicity Goodyear-Smith		Click here
Helen Petousis-Harris		25/07/2013
Stephen Ram		5/10/2013
Colleen VanLaar		28/11/2013
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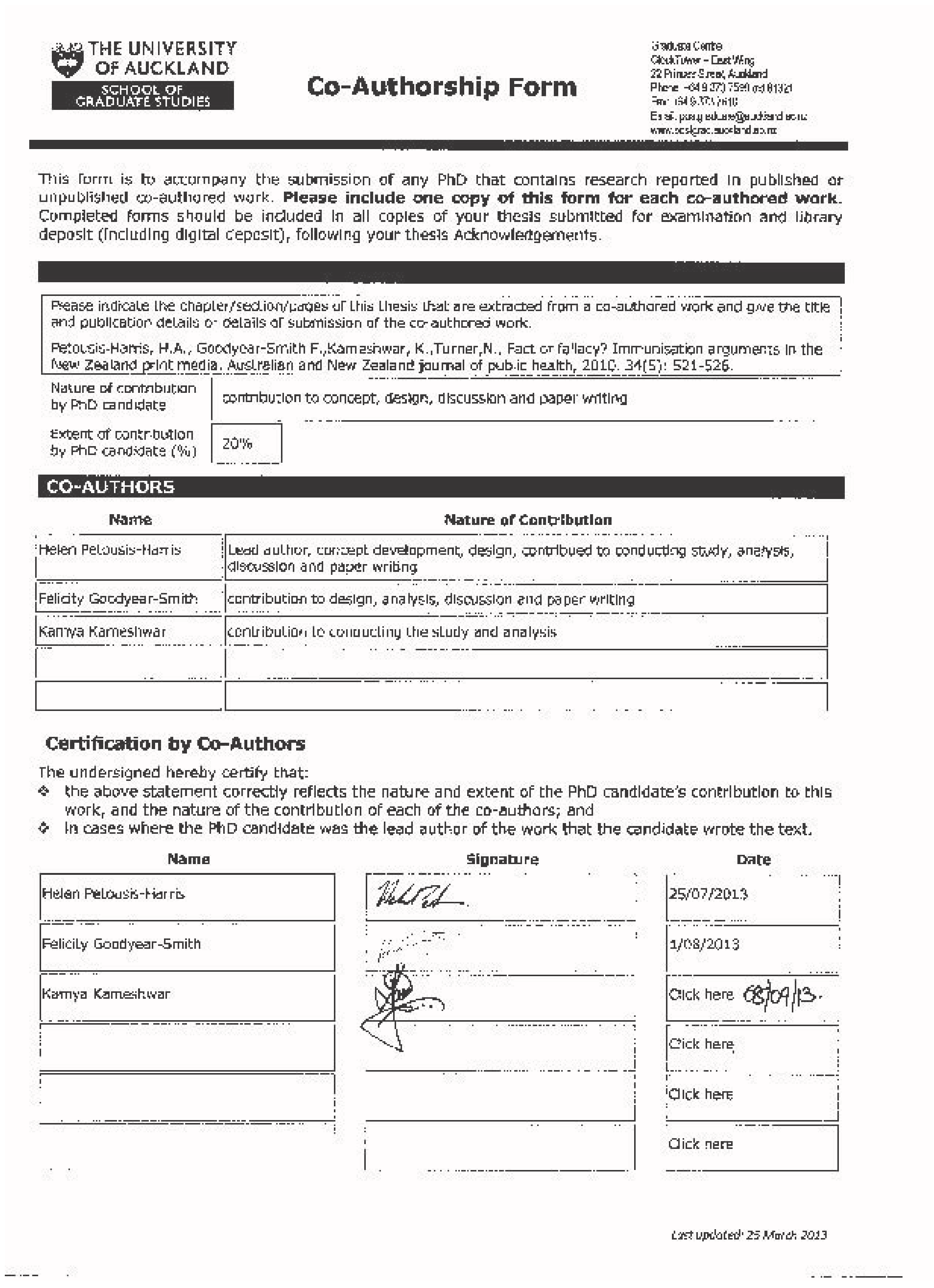

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Petousis-Harris, H.A., Goodyear-Smith F.,Kameshwar, K.,Turner,N., Fact or fallacy? Immunisation arguments in the New Zealand print media. Australian and New Zealand journal of public health, 2010. 34(5): 521-526.

Nature of contribution by PhD candidate	contribution to concept, design, discussion and paper writing
Extent of contribution by PhD candidate (%)	20%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Lead author, concept development, design, contribued to conducting study, analysis, discussion and paper writing
Felicity Goodyear-Smith	contribution to design, analysis, discussion and paper writing
Kamya Kameshwar	contribution to conducting the study and analysis

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Kamya Kameshwar		Click here 08/09/13.
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Turner, N., York, D.,Petousis-Harris, H., The use and misuse of media headlines: lessons from the MeNZB™ immunisation campaign. ,2009 NZMed J 122(1291)

Nature of contribution by PhD candidate	Lead author, developed concept, designed, undertook study and analysis, undertook discussion and paper writing
Extent of contribution by PhD candidate (%)	80%

CO-AUTHORS

Name	Nature of Contribution
Deon York	contributed to conducting the study, analysis and paper writing
Helen Petousis-Harris	contributed to concept, design, discussion and paper writing

Certification by Co-Authors

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Co-Authorship Form

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Please indicate the chapter/section/pages of this thesis that are extracted from a co-authored work and give the title and publication details or details of submission of the co-authored work.

Petousis-Harris, H.Goodyear-Smith F.,Turner, N.,Soe, B., Family physician perspectives on barriers to childhood immunisation. Vaccine, 2004. 22(17): 2340-2344.

Nature of contribution by PhD candidate	contribution to concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	30%

CO-AUTHORS

Name	**Nature of Contribution**
Helen Petousis-Harris	Lead author, contribution to concept, design, analysis, discussion and paper writing
Felicity Goodyear-Smith	contribution to design, analysis, discussion and paper writing
Ben Soe	contribution to design, conducting study, analysis and discussion

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- in cases where the PhD candidate was the lead author of the work that the candidate wrote the text.

Name	**Signature**	**Date**
Helen Petousis-Harris		25/07/2013
Felicity Goodyear-Smith		31/07/2013
Ben Soe		1/08/2013
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Goodyear-Smith, F., Petousis-Harris, H.,Turner, N., Immunization champions: characteristics of general practitioners associated with better immunization delivery. Human vaccines, 2009. 5(6): 403-411.

Nature of contribution by PhD candidate	contributed to concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	30%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, contributed to design, analysis, discussion and lead author on paper writing
Helen Petousis-Harris	contrubted to design, analysis, discussion and paper writing

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Felicity Goodyear-Smith		31/07/2013
Helen Petousis-Harris		25/07/2013
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Petousis-Harris, H.,Goodyear-Smith, F.,Turner, N.,Soe, B., Family practice nurse views on barriers to immunising children. Vaccine, 2005. 23(21): 2725-2730.

Nature of contribution by PhD candidate	contribution to concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	30%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Lead author, contributed to concept, design, analysis, discussion and paper writing
Felicity Goodyear-Smith	contribution to design, analysis, discussion and paper writing
Ben Soe	contribution to design, analysis, discussion and paper writing

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Fellicity Goodyear-Smith		31/07/2013
Ben Soe		1/08/2013
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Desmond, N.,Grant, C., Goodyear-Smith, F., Turner, N., Petousis-Harris, H., Nurses make a difference in immunisation service delivery. Australian Journal of Advanced Nursing, 2011. 28(4): 28-35.

Nature of contribution by PhD candidate	contributed to design, development, discussion and paper writing
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Natalie Desmond	Lead author, involved in design, conducting study, analysis, discussion and paper writing
Cameron Grant	contributed in concept development, design, data analysis, discussion and paper writing
Felicity Goodyear-Smith	contributed in design, development, discussion and paper writing
Helen Petousis-Harris	contributed in design, development, discussion ad paper writing

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Name	Signature	Date
Natalie Desmond		1/08/2013
Cameron Grant		1/08/2013
Felicity Goodyear-Smith		29/07/2013
Helen Petousis-Harris		25/07/2013
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Goodyear-Smith, F.,Petousis-Harris,H., Soe, B., Turner, N., Comparison of general practitioner and practice nurse perceived barriers to immunisation uptake. New Zealand Family Physician, 2005. 32(3): 164 - 170.

Nature of contribution by PhD candidate	contribution to concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	20%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, contribution to design, analysis, discussion and paper writing
Helen Petousis-Harris	contribution to concept, design, analysis, discussion and paper writing
Ben Soe	contribution to analysis, discussion and paper writing

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Ben Soe		Click here
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Goodyear-Smith, F., York, D.,Petousis-Harris, H., Turner, N., Copp, J.,Kerse, N., Grant, C., Recruitment of practices in primary care research: the long and the short of it. Family practice, 2009. 26(2): 128-136.

Nature of contribution by PhD candidate	contributed to project management team ,design, conducting study including recruiting practices,analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	20%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, contributed to project management team, design, conducting study, analysis, discussion and paper writing
Deon York	conducted study, data collection and paper writing
Helen Petousis-Harris	contributed to project management team, design,discussion and paper writing
Ngaire Kerse	contributed to project management team, design, conducting study and paper writing
Cameron Grant	Principle investigator of overall project, contributed to project management team, design, discussion and paper writing

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Name	Signature	Date
Felicity Goodyear-Smith		29/07/2013
Deon York		31/07/2013
Helen Petousis-Harris		25/07/2013
Ngaire Kerse		29/07/2013
Cameron Grant		1/08/2013
Jackie Copp		3/09/2013

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Grant CC, Petousis-Harris H,Turner N, Goodyear-Smith F, Kerse N, Jones R, York D, Desmond N, Stewart J. Primary care practice and health professional determinants of immunisation coverage. J Paediatrics and Child Heatlh 47 (2011)541-549

Nature of contribution by PhD candidate	contributed to concept development, design, project planning, recruitment and implementation team, discussion and paper writing
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Cameron Grant	Principle investigator, contributed to concept development, design, project planning and implementation, conducting study, analysis, discussion and paper writing
Deon York	researcher for the project, contributed to recruitment, data collection, discussion and paper writing
Felicity Goodyear-Smith	contributed to design, project planning, recruitment and implementation team, discussion and paper writing
Helen Petousis-Harris	contributed to concept development, design, project planning and implementation team, discussion and paper writing
Rhys Jones	contributed to design, discussion and paper writing
Natalie Desmond	contributed to design, discussion and paper writing
Ngaire Kerse	contributed to design , discussion and paper writing
Joanna Stewart	contributed to project planning for statistical desing and analysis and paper writing

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Name	Signature	Date
Deon York		31/07/2013
Helen Petousis-Harris		25/07/2013
Cameron Grant		1/08/2013
Felicity Goodyear-Smith		1/08/2013

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Nature of contribution by PhD candidate	contributed to concept development, design, project planning, recruitment and implementation team, discussion and paper writing
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Ngaire Kerse	contributed to project planning, recruitment, design , discussion and paper writing
Ryns Jones	contributed to design , discussion and paper writing
Natalie Desmondt	contributed to design, discussion and paper writing
Joanna Stewart	contrubed to project planning for statistical design and analsis and paper writing

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Name	Signature	Date
Rhys Jones		5/08/2013
Natalie Desmond		5/08/2013
Joanna Stewart		2/09/2013
Ngaire Kerse		3/09/2013
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Petousis-Harris H, Grant CC, Goodyear-Smith F, Turner N, York D, Jones R, Stewart J.What contributes to delays? The primary care determinants of immunisation timeliness in New Zealand. J Prim Health Care 2012 Mar;4(1):12-20.

Nature of contribution by PhD candidate	contributed to concept development, design, project planning, recruitment and implementation team, discussion and paper writing
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Helen Petousis-Harris	Contributed to concept development, design, project planning and implementation, conducting study, analysis, discussion and led the paper writing
Cameron Grant	Principle investigator for larger study, contributed to concept development, design, project planning and implementation, conducting study, analysis, discussion and paper writing
Felicity Goodyear-Smith	contributed to design, project planning, recruitment and implementation team, discussion and paper writing
Deon York	researcher for the project, contributed to recruitment, data collection, discussion and paper writing
Rhys Jones	contributed to design, discussion and paper writing
Joanna Stewart	contributed to project planning for statistical design and analysis

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Helen Petousis-Harris		25/07/2013
Cameron Grant		1/08/2013
Felicity Goodyear-Smith		1/08/2013

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Rhys Jones		5/08/2013
Joanna Stewart		2/09/2013

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Grant CC, Turner NM, York DG, Goodyear-Smith F, Petousis-Harris HA. Factors associated with immunisation coverage and timeliness in New Zealand. The British Journal of General Practice 2010;60(572):e113.

Nature of contribution by PhD candidate	contributed to concept development, design, project planning, recruitment and implementation team, discussion and paper writing
Extent of contribution by PhD candidate (%)	15%

CO-AUTHORS

Name	Nature of Contribution
Cameron Grant	Principle investigator, contributed to concept development, design, project planning and implementation, conducting study, analysis, discussion and paper writing
Deon York	researcher for the project, contributed to recruitment, data collection, discussion and paper writing
Felicity Goodyear-Smith	contributed to design, project planning, recruitment and implementation team, discussion and paper writing
Helen Petousis-Harris	contributed to concept development, design, project planning and implementation team, discussion and paper writing

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Turner, N., Grant, C., Goodyear-Smith, F., Petousis-Harris, H., Seize the moments: missed opportunities to immunize at the family practice level. Family practice, 2009. 26(4): p. 275-278

Nature of contribution by PhD candidate	Lead author, contributed to concept development project design, fully conducted the study, some analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	70%

CO-AUTHORS

Name	Nature of Contribution
Cameron Grant	Supervisor for my Masters thesis on this topic, contributed to concept development, project design, analysis, discussion and paper writing
Felicity Goodyear-Smith	contributed to project design, discussion and paper writing
Helen Petousis-Harris	contributed to project design, discussion and paper writing

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Cameron Grant		31/07/2013
Felicity Goodyear-Smith		26/07/2013
Helen Petousis-Harris		25/07/2013
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Turner, N., Rouse, P., Airey, S., Petousis-Harris, H., The cost of immunising at the general practice level. Journal of primary health care, 2010. 1(4): 286-296

Nature of contribution by PhD candidate	Principle investigator, lead author, contributed to concept, design, analysis, discussion and paper writing
Extent of contribution by PhD candidate (%)	60%

CO-AUTHORS

Name	Nature of Contribution
Paul Rouse	contributed to design, majority of the analysis, discussion and paper writing
Stacey Airey	conducted the study, contributed to design, analysis and paper writing
Helen Petousis-Harris	contributed to discussion and paper writing

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Name	Signature	Date
Paul Rouse		24/07/2013
Helen Petousis-Harris		30/07/2013
Stacey Airey		8/08/2013
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Goodyear-Smith, F.,Grant, C.,York, D.,Kenealy, T.,Copp,J.,Petousis-Harris, H., Turner, N.,Kerse, N., Determining immunisation coverage rates in primary health care practices: a simple goal but a complex task. International journal of medical informatics, 2008. 77(7): 477-485.

Nature of contribution by PhD candidate	contributed to concept, design, conducting study and paper writing
Extent of contribution by PhD candidate (%)	10%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, designed concept, major contribution to design, analysis, discussion and paper writing
Cameron Grant	contributed to analysis, discussion and paper writing
Deon York	contributed to conducting the study, data collection and analysis
Jackie Copp	project manager, contributed to running the study, data collection and analysis
Helen Petousis-Harris	contributed to analysis, discussion and paper writing
Tim Kenealy	Contributed to analysis and paper writing

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Name	Signature	Date
Felicity Goodyear-Smith		1/08/2013
Cameron Grant		1/08/2013
Deon York		1/08/2013
Jackie Copp		3/09/2013
Helen Petousis-Harris		25/07/2013

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Tim Kenealy		5/09/2013

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Nature of contribution by PhD candidate	contributed to concept, design, conducting study and paper writing
Extent of contribution by PhD candidate (%)	10%

CO-AUTHORS

Name	Nature of Contribution
Felicity Goodyear-Smith	Lead author, designed concept, major contribution to design, analysis, discussion and paper writing
Cameron Grant	contributed to analysis, discussion and paper writing
Deon York	contributed to conducting the study, data collection and analysis
Jackie Copp	project manager, contributed to running the study, data collection and analysis
Helen Petousis-Harris	contributed to analysis, discussion and paper writing
Tim Kenealy	Contributed to analysis and paper writing
Ngaire Kerse	contributed to analysis, discussion and paper writing

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Tim Kenealy		5/09/2013
Ngaire Kerse		5/09/2013

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Abbreviations

This section provides a list of the abbreviations and acronyms used in this thesis

AEFI	Adverse Event Following Immunisation
AHB	Area Health Board
CATI	Computer-assisted telephone survey tool
CDC	The Communicable Diseases Centre, USA
CI	Confidence Intervals
CME	Continuing Medical Education
CHW	Community Health Worker
DHB	District Health Board
DHBNZ	District Health Board New Zealand: the national organisation for DHBs
DQA	Data Quality Audit
DT	Diphtheria tetanus combination vaccine
DTaP	The combination vaccine of diphtheria-tetanus, acellular pertussis
DTwP	The combination vaccine of diphtheria-tetanus-whole cell pertussis
DTPH	The combination vaccine of diphtheria-tetanus-whole cell pertussis and HiB
EPI	The Expanded Programme of Immunization from the World Health Organization
ESR	The Institute of Environmental Science and Research, a government owned NZ Crown Research Institute
GAVI	Global Alliance for Vaccines and Immunisation (private public global health partnership)
GP	General Practitioner
HBL	Health Benefits Limited

HCP	Health Care Provider
HCW	Health Care Worker
HepB	Hepatitis B vaccine
HFA	Health Funding Authority
HHE	Hypotonic Hypotensive Episode (after receiving a vaccination)
Hib	Haemophilus influenza type b vaccine
HPV	Human papillomavirus vaccine
HRC	Health Research Council
IBS	Immunisation Benefit Subsidy (government funding to practices)
IMAC	Immunisation Advisory Centre, University of Auckland
IMCI	Integrated Management of Childhood Illness
IPA	Independent Practitioner Association
LMC	Lead Maternity Caregiver
MMR	Measles-mumps-rubella combination vaccine
MO	Missed opportunity to immunise
MoH	Ministry of Health
NHI	National Health Index: The individual unique NZ identifier number
NIP	National Immunisation Programme
NIR	National Immunisation Register
NZ	New Zealand
OIS	Outreach Immunisation Service
OPV	Oral Polio Vaccine
OR	Odds Ratio
PHC	Primary Health Care
PHO	Primary Health Organisation
PI	Principal Investigator

PMS	Practice Management Systems
PN	Practice Nurse
RCT	Randomised Controlled Trial
RHA	Regional Health Authority
RNZCGP	Royal New Zealand College of General Practitioners
SES	Socioeconomic Status
TT	Tetanus Toxoid Vaccine
UK	United Kingdom
UNICEF	United Nations Children’s Fund
USA	United States of America
VPD	Vaccine-Preventable Disease
WIC	Women, Infant and Children – the USA programme for low income families
WHO	World Health Organization

CHAPTER 1 INTRODUCTION

1.1 Background

I am a trained general practitioner (GP) with a background in paediatrics. I became interested in immunisation in 1996 when I took on a role as a regional immunisation coordinator at the University of Auckland. The primary intention was to develop a service that used an academic interface to focus on the challenges for New Zealand (NZ) around low immunisation coverage rates.

From this position in 1996 I created and then evolved the Immunisation Advisory Centre (IMAC). IMAC grew from a small regional service funded by the Northern Regional Health Authority (RHA) to become a national immunisation coordination service in 1998 funded by the Ministry of Health (MoH). IMAC originated from the recognition that NZ had poor immunisation coverage and that there was the need for an academic base to support service delivery improvement in immunisation coverage, particularly for the childhood national immunisation programme (NIP).

IMAC is now a national organisation situated under Auckland Uniservices, currently employing around 35 staff around the country and involved in a range of services, including academic research, undergraduate and postgraduate education, strategic advice, communications management, national coordination, and service delivery. Its major contracts are held with the MoH; with a range of others with many DHBs (DHBs). Research funding is procured competitively through a range of sources including the Health Research Council (HRC), USA Communicable Diseases Centre (CDC) and pharmaceutical companies.

1.2 History of this body of research

This thesis is intended to integrate 14 years of research, encompassing a time period from 1999 to 2013, in which I have been actively engaged with colleagues in attempting to gain an understanding of the key factors behind what can contribute to or hinder improvements in immunisation coverage and timeliness of delivery for the childhood immunisation programme in the NZ context.

This thesis starts with a description of the relevant history in this period of time for immunisation coverage rates in NZ. The focus is on the infant immunisation schedule up to the age of two years. The thesis incorporates 29 papers in which I was involved in developing and publishing in peer-reviewed journals both as a primary and as a co-author. I particularly wish to acknowledge the significant contribution of all this work by my colleagues Associate Professor Cameron Grant, Professor Felicity Goodyear-Smith, Dr Helen Petousis-Harris, Dr Lynn Taylor, and Tracey Poole.

1.2.1 General background on Immunisation

Vaccines have prevented more deaths, disability and suffering than any other medical discovery or intervention (1).

Childhood immunisation is one of the most cost-effective activities in healthcare. Every country in the world has an NIP and these programmes have had a significant impact on childhood diseases. Immunisation has eradicated smallpox from the world since 1979, is close to eliminating polio, and has delivered huge reductions in rates of other significant childhood diseases. For example, United States of America (USA) data report a greater than 92% decline in cases and greater than 99% decline in deaths due to diphtheria, mumps, pertussis, and tetanus as a result of vaccines recommended on the USA national childhood schedule (2). Reductions, particularly in morbidity, can be maximised if universal high coverage is achieved with all these vaccines, and further gains are possible with the introduction of new vaccines for other significant childhood diseases, such as has been seen in the US with the introduction of vaccines against rotavirus and varicella disease (2). Despite these successes, many countries continue to have poor immunisation coverage rates, and associated challenges with higher rates and on-going outbreaks of VPDs, such as measles and pertussis, that could be eliminated or better controlled via achieving higher immunisation coverage with national immunisation schedule vaccines. Due in large part to historic low rates of immunisation coverage, NZ continues to experience outbreaks, particularly of measles (3) and pertussis (4).

Traditionally NZ has had poor immunisation coverage for its infant and childhood immunisation programmes, with significant disparities particularly seen for children from lower socioeconomic backgrounds, and of Māori or Pacific Island ethnicity. A national immunisation coverage survey in 1991 demonstrated that less than 60% of NZ children were fully immunised by two years of age, including only 42% of Māori and 45% of Pacific children (5). Some improvement was seen by 2005 when 77% of children (69% of tamariki Māori) were fully immunised at two years of age (6).

1.3 My research on the factors associated with immunisation coverage in NZ

From 1999 onward I have been engaged in research looking at a range of factors that affect immunisation coverage in the NZ setting. Early research focused on aspects of the NZ policy environment that affected immunisation uptake at 6 weeks of age (7) and considered questions around why immunisation coverage was so low at this event (8). Following this research, with colleagues in the Department of General Practice and Primary Health Care, I undertook qualitative research focusing on attitudes and knowledge with parents (9,10), pregnant mothers (11), healthcare providers (12-14), and the NZ print media (15-18). Working with a visiting United Kingdom (UK) colleague with expertise in psychology, we researched and published on parental concerns in the crucial antenatal period (19) and from there trialled an antenatal decision making tool (20).

Following this early research I was a member of a research team that was supported by an HRC grant to focus on the determinants of immunisation coverage at the primary care level. The Principal Investigator was Associate Professor Cameron Grant from the Department of Paediatrics and the other contributing researchers were Professor Felicity Goodyear-Smith from the Department of General Practice and Primary Health Care, and Dr Helen Petousis-Harris from the IMAC. This research produced publications around the role of GPs (21), practice nurses (PNs)(22), practice systems (23,24), and the interactions between these (25,26), and missed opportunities to vaccinate at the practice (27). Supporting these findings were three further studies I was involved with: an analysis of immunisation coverage data from the National Immunisation Register (NIR) (28), data usage and audit at the general practice level (29), and a cost analysis of immunising at the general practice level (30).

Using the information from the above studies with Professor Felicity Goodyear-Smith as the Principal Investigator (PI), we designed an intervention study: a randomised controlled trial (RCT) to improve timeliness of delivery at the six week visit (31).

I then synthesised and utilised summary data from the above research to publish commentary articles (32,33).

Building on from the research above, we moved into an area of research we are calling ‘best practice models’ which is using the themes from this prior research and looking at its application in the working general practice environment. The research in this area was led by Dr Lynn Taylor and involved identifying factors at the general practice level that supported the achievement of high immunisation coverage in the practice population (34). Building on this research, I am currently the Principal Investigator working with Dr Lynn Taylor on an HRC-funded study that is translating the findings from the ‘best practice’ research into an intervention package called a ‘best practice model’ for practices with low immunisation coverage. This study is currently in the final data collection phase as of 2014.

1.4 Hypotheses

- There are identifiable contributory factors that affect the delivery and timeliness of delivery of the infant/childhood immunisation programme.
- The factors that affect delivery and timeliness of delivery of the infant immunisation programme also affect the traditional equity gaps that are seen with lower immunisation coverage and timeliness of delivery for children from lower socioeconomic backgrounds, and the ethnic groups of Māori and Pacific.

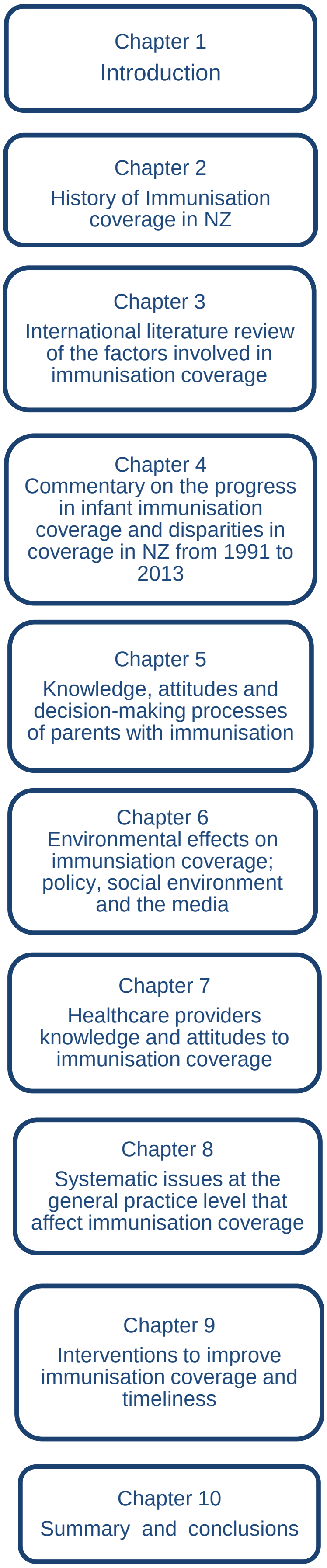
1.5 Aims of the study

I. Document the history of improvement in immunisation coverage in the NZ context since 2000 for the childhood immunisation schedule for infants to the age of 2 years.
II. Document the reduction in the equity gap for immunisation coverage for Māori and Pacific infants and those from low income backgrounds.
III. Discuss and analyse the contributory factors behind the reasons for the improvement in immunisation coverage and reduction in disparities.
IV. Identify remaining on-going challenges for improving and maintaining high immunisation coverage, both at 2 years of age and at 8 months of age (the national targets).

1.6 Overall structure of this thesis

The overall structure of this thesis is shown in Figure 1.1.

In Chapter 2 I record and discuss the history of immunisation coverage and NZ policy response to low coverage, from the initial recorded national immunisation survey in 1991 to the end of 2012. Chapter 3 is an international literature review I have undertaken of the factors that are positively and negatively identified with affecting immunisation coverage. Chapter 4 presents my academic published commentary around the progress and challenges for immunisation coverage through the period 2000 to 2012. Chapter 5 presents my research with parents, looking at factors around parental knowledge, attitudes and decision-making processes, with a particular focus on the antenatal period. Chapter 6 looks at broader social environmental influences, in particular the effects of policy on immunisation coverage and the role and effects of the media. Chapter 7 focuses on the contribution of healthcare providers: their knowledge and attitudes. Chapter 8 looks at the issues at the service delivery level. I then move on to presenting the results of intervention studies in Chapter 9. Finally, Chapter 10 synthesises and combines all the results with summary commentary and conclusions.


Chapter 1
Introduction
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Chapter 3
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Environmental effects on immunsiation coverage; policy, social environment and the media
Chapter 7
Healthcare providers knowledge and attitudes to immunisation coverage
Chapter 8
Systematic issues at the general practice level that affect immunisation coverage
Chapter 9
Interventions to improve immunisation coverage and timeliness
Chapter 10
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Figure 1.1: Overall structure of this thesis

1.7 Summary of Chapter 1

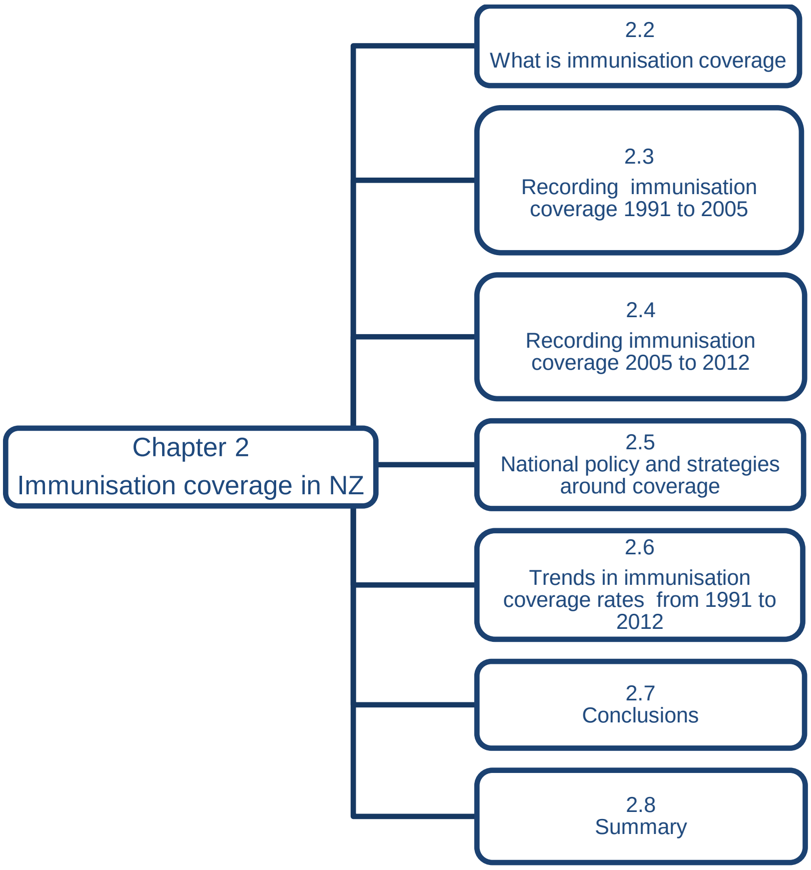
This chapter has presented the background and outline of the structure for this thesis. It presents the history behind the topic and the research with which I have been involved over this period. It then presents the hypothesis that there are identifiable contributory factors associated with immunisation coverage rates. I have listed the aims to address this hypothesis and outline the structure of the thesis including the purpose and outline for each of the chapters.

CHAPTER 2 HISTORY OF THE PROGRESS IN INFANT IMMUNISATION COVERAGE IN NZ FROM 1991 TO 2013

2.1 Outline of Chapter 2

The aim of this chapter is to record the history of immunisation coverage rates in NZ from the initial recorded national immunisation survey in 1991 to the end of 2012. This will include national reports, strategies, and policies that are recognising and responding to immunisation coverage issues through this era. Immunisation coverage in this context is specific to the infant/young childhood programme, which is delivered in NZ at the ages of six weeks,three months, five months and 15 months.

The purpose of starting this thesis here is to explain the background for the research presented, which is a body of work focused on factors that affect immunisation coverage over this period of time. Much of the presented research will be referring back to the context in this chapter.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2.3
Recording immunisation coverage 1991 to 2005
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Recording immunisation coverage 2005 to 2012
2.5
National policy and strategies around coverage
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Conclusions
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Summary

Figure 2.1: Outline of Chapter 2

Every country in the world has an NIP that delivers specified vaccines at set ages to target groups. Vaccines on national schedules can be delivered either universally to all in the age group or targeted to those at higher risk of a specific disease. NZ has had an immunisation programme for all children (universal) since November 1960 when the diphtheria-tetanus-whole cell pertussis (DTwP) vaccine was introduced to infants at three, four, and five months of age. Since that time, vaccines have been altered to include protection against other diseases and extra visits have been added (35). For a full list of the changes to the schedule refer to the NZ Immunisation Handbook 2011 (36).

2.2 What is immunisation coverage?

Immunisation coverage is the percentage of children who have received all of the immunisations on the National Childhood Immunisation Schedule for their age (35).

Immunisation coverage consists of a measurement of the proportion of individuals in the eligible population who have received the recommended vaccination events (37). There are different ways of measuring immunisation coverage. The World Health Organization (WHO) and The United Nations Childrens Fund (UNICEF) publish comparative immunisation coverage internationally by country, by year and by vaccine (38). Because different countries have different immunisation schedules it can be difficult to compare them. A standard comparison used is the measure of those fully immunised at the age of one year, which usually covers a primary course of three doses of diphtheria-tetanus-pertussis containing vaccines. Measuring different antigens and at different times will give a range of information on the effectiveness of the programme. Furthermore, the way in which data for immunisation coverage are collected can vary considerably; accuracy is dependent on how the data are collected.

2.2.1 Why measure immunisation coverage?

There are two main purposes for measuring immunisation coverage:

I. To assess the overall effectiveness of the programme.

The purpose for gaining high immunisation coverage is to control disease. Accurate data on immunisation coverage rates are useful to be able to understand how effective an immunisation strategy is, how universally it is being taken up, monitor progress over time and to monitor geographical areas or subgroups where coverage rates may be lower.

II. To have accessible data on subgroups and individuals who may be missing out on the offered programme.

Coverage can also be measured so that the information on those who have not been immunised at the appropriate time can be fed back to service planners and providers, to restructure services and to develop services to find those who have missed out. Data can be used to identify high risk areas, high risk groups or specific individuals to be followed up. It is well recognised internationally that some subpopulations are at higher risk of not receiving their immunisation events on time or at all; in particular, those from lower socioeconomic groups and indigenous and immigrant ethnic groups (39). In NZ, Māori children, Pacific children, and children from areas of poverty historically have been particularly at risk of being under-immunised (40).

2.2.2 Immunisation coverage measurements

Coverage can be measured for any vaccine delivered. In the context of this thesis, measurement of immunisation coverage is restricted to the infant immunisation programme vaccine events up to the age of two years. The vaccines delivered, termed ‘vaccination events’, are given as combination vaccines that are recommended to be delivered at the ages of 6 weeks, 3 months, 5 months and 15 months. Prior to 1996 there was also an 18 month vaccination event.

There are two general ways of measuring coverage:

I. Measurement of the vaccination event or events if there is more than one vaccine.
II. Measurement of overall vaccination coverage at a certain age point.

Specific age time points have been used for national targets. A common international measure is fully immunised by one year of age (38). The most common target measure in NZ has been a measure of fully immunised by two years of age, i.e. all children up to the day before their second birthday. Since 2005, NZ immunisation data have been reported at 6 months, 12 months, 18 months and 2 years of age. Since new national targets were introduced in 2011, data are also reported for 2012 at 8 months of age (37).

2.2.3 Timelines of delivery of immunisation events

Measurements at certain time points, such as at two years of age, are useful for comparing the functioning of the programme over time. However, vaccinations need to be delivered as close as possible to the recommended age to give the optimal performance for disease control. For example, NZ data has shown that delays in delivery of the infant immunisation programme lead to higher rates of hospitalisation with pertussis disease (4).

Hence, the most useful measures of coverage also need to include measurements of timeliness of delivery for immunisation events. Clearly, the immunisation coverage measurement for timeliness varies depending on what definition of ‘delayed’ is used. To measure the uptake of any vaccination event, NZ has traditionally used either a 30 day or a one month window and accepted that any vaccination received within 30 days or one month of the due age time is considered fully vaccinated on time for that age group.

2.3 Recording immunisation coverage data in NZ from 1991 to 2005

Prior to 1991, there was no systematic approach in NZ to recording or reporting on immunisation coverage data.

2.3.1 National Immunisation coverage survey 1991-1992

In 1991, in recognition of the lack of information on uptake of the infant immunisation schedule vaccination programme, the fourteen Area Health Boards (AHBs), in consultation with the NZ Communicable Disease Centre, undertook an assessment of the proportion of all two-year-olds in the country who had received their childhood immunisation series (5). The AHBs were grouped under four Regional Health Authorities (RHAs). These were the North RHA (comprised of Northland and Auckland AHBs), the Central-North RHA (Bay of Plenty, Taranaki, Tairawhiti and Waikato AHBs), the Central-South RHA (Hawkes Bay, Manawatu-Wanganui, Wellington and Nelson-Marlborough AHBs) and the South RHA (Canterbury, West Coast, Otago and Southland AHBs).

2.3.1.1 Methods

The methodology employed by the group conducting the survey was based on that developed by the WHO and used widely in countries where their Expanded Programme of Immunization (EPI) was delivered (41). It consisted of a representative sample of two and three year olds from NZ households. This was obtained by initially selecting a simple random sample of geographic starting points based on the 1991 census data, distributed across each of the four RHAs. Recruitment began from each of these starting points then involved successively visiting the next nearest household, in turn, until a child in the eligible age residing there was identified and the family successfully interviewed. Interviewers visited up to three times, one of which was out of work hours. Immunisation history was obtained from the records in the child's Health and Development Record Book, known as the Plunket book or Well Child Book. If this was unavailable or incomplete, consent was obtained to check the information from records retained by the GPs. Descriptive statistics were used to characterise the survey groups for demographic attributes and levels of vaccination coverage, and caregiver attitudes and knowledge regarding immunisation and VPDs.

2.3.1.2 Results

In total, 706 households were interviewed. The mean household size was 4.5 persons per household, ranging from 5.0 per household in the North RHA to 4.2 in the Central-South RHA. In over 90% of the households the respondent was the mother. Approximately a quarter of the households had moved two or more times since the child's birth. There were higher rates of households receiving benefits in the Central and North (28.2%) compared to the South (13.2%). The mean age of the child was 3.0 years at the time of interview.

2.3.1.3 Attitudes/knowledge

In all areas, over 90% of respondents expressed a belief in the need for childhood immunisations; this was lower in the North region at 90.6%, 93.8% in Central-South and higher in the South at 97.6%. This was consistent across all ethnic groups. All respondents were aware of the availability of immunisation services. Just under one-third cited barriers, either physical or financial, that could limit their access to, and utilisation of, immunisation services.

There was general uncertainty about specific indications/contraindications for immunisation and more than two-thirds of respondents in all areas expressed the desire for more information from vaccination promoters. Virtually all respondents perceived that doctors and nurses were actively promoting immunisation for children; between one-third and one-half of all respondents reported having difficulties remembering when their children were due to receive their immunisations. Overall, 87% expressed the belief that reminders of when their children were due for immunisation (either by telephone or letter) would be helpful.

2.3.1.4 Coverage

The Health and Development Record Book was available for about 80% of all children and two-thirds of these were kept up-to-date for the immunisation record. This was lower in the Central–North RHA where slightly less than half were up to date.

Coverage levels reported by the age of two were above 90% through the entire country for the first dose of Diphtheria-Tetanus-whole cell Pertussis (DTwP), post neonatal Hepatitis B (HepB), and Oral Polio Vaccine

(OPV) and were around 80% for completion of all vaccinations due before one year of age. Coverage levels were around 70% for the vaccinations scheduled in the second year of life, except for measles-mumps-rubella (MMR) vaccine which was around 80%. Coverage rates were highest for the South and Central-South regions. Refer Figure 2.2. Overall, by their second birthday, less than 60% of children in all regions had been fully immunised (with three DTwP and OPV doses, one MMR, and at least three HepB doses). By the time of interview (at any age from two to the fourth birthday), coverage levels had increased by 5 to 10%. Refer Table 2.1.

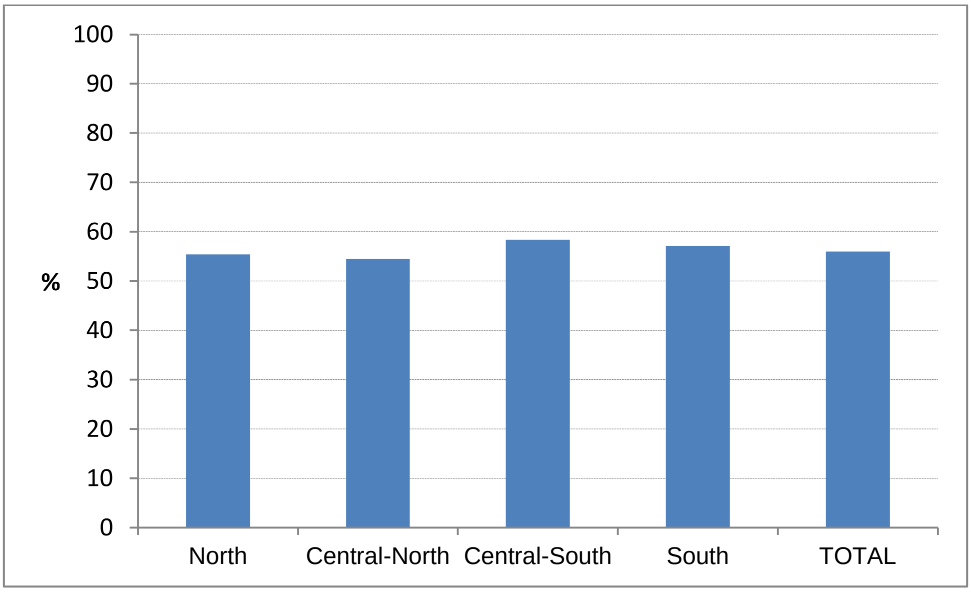

Figure 2.2: Immunisation coverage rates for the schedule vaccines at two years of age by Regional Health Authority, 1991-1992

2.3.1.5 Timelines

Using a timeliness measure of up to one month after the due vaccination date, around 80% of children received their first doses of DTwP and HepB on time; generally less than 70% of children received other vaccinations in the primary course on time. For the second year of life, less than 50% of children received their vaccines within one month of the due date. For most events, timeliness was better in the South RHA than in the other three RHAs. Table 2.1 shows the immunisation coverage rates by ‘timeliness’. Timeliness here is defined as receiving the vaccine within one month of the due date. Overall, timeliness of delivery was lower in the Northern region and lower for the later vaccine events.

Table 2.1: "On Time" Immunisation coverage rates, by Regional Health Authority, 1991 - 1992

Vaccination Event	North RHA (95% CI)	Central-North RHA (95% CI)	Central-South RHA (95% CI)	South RHA (95% CI)
DTwP 1: 6 weeks	78.9 (71.9-84.5)	80.3 (73.6-85.8)	80.9 (74.2-86.2)	85.1 (78.8 – 89.9)
HepB 1: 6 weeks	78.9 (71.9-84.5)	69.7 (62.3-76.2)	74.2 (67.0 – 80.3)	76.6 (69.5-82.5)
DTwP 2: 3 months	63.4 (55.8-70.5)	66.9 (59.4-73.6)	63.5 (55.9-70.5)	74.3 (67.0-80.4)
OPV 1: 3 months	72.0 (64.6-78.4)	71.9 (64.6-78.3)	70.8 (63.4-77.2)	80.0 (73.1- 85.5)
HepB 2: 3 months	64.6 (56.9-71.5)	52.2 (44.7-59.7)	62.9 (55.3-69.9)	60.0 (52.3-67.2)
DTwP 3: 5 months	49.7 (42.1-57.4)	53.9 (46.3 – 61.4)	49.4 (41.9 – 57.0)	57.7 (50.0 – 65.1)
OPV 2: 5 months	54.3 (46.6 – 61.8)	58.4 (50.8-65.7)	52.8 (45.2 – 60.3)	59.4 (51.7 – 66.7)
Measles/ MMR: 12-15 months	47.4 (39.8 – 55.1)	55.1 (47.4-62.5)	52.8 (45.2-60.3)	57.1 (49.4 – 64.5)
HepB 3: 12- 15 months	44.6 (37.1 – 52.3)	48.3 (40.8 – 55.9)	46.6 (39.1-54.3)	45.1 (37.6 – 52.8)
DT: 18 months	39.4 (32.1 – 47.1)	43.3 (35.9-50.9)	47.8 (40.2-55.4)	45.1 (37.6 – 52.8)
OPV 3: 18 months	36.0 (28.9 – 43.6)	41.0 (33.7 – 48.6)	43.3 (35.9 – 50.9)	41.1 (33.8 – 48.80

2.3.1.6 Reasons for under-immunisation

Of the 148 caregivers who provided reasons for incomplete immunisation, the most frequently stated reason was a medical contra-indication to receiving a specific vaccine in 53/148 (36%). The second most common reason was that they had *never got around to it* for 20/148 (14%). Overall, only a small number, 6/148 (4%), noted anti-vaccination sentiments and 3/148 (2%) noted financial concerns as the principal reasons for not immunising.

Analysis of potential risk factors for not being immunised suggested that children who lived in a household where the principal source of income was from a government benefit were, on average, two-thirds as likely to have received the full series of immunisations compared to children who lived in a household where the principal source of income was not from a benefit. Children whose principal caregiver identified as being Māori or part-Māori were around 70% as likely to have received the full series compared with children whose caregiver identified from a European ethnic background. This difference was only statistically significant in the North RHA. There was no significant difference in immunisation coverage for children whose principal caregiver identified as being a Pacific Islander compared with European. Those children whose principal caregiver had not achieved school certificate educational qualifications were only 69% as likely to have been fully immunised in the North RHA, but there were no statistically significant differences in the other regions. For children who had moved two or more times since birth there was a non-significant, but consistent, decreased likelihood of being fully vaccinated at two years of age. There was a non-significant trend that children with mothers younger than 25 years of age at the time of interview were more likely to have been fully immunised, except in the South RHA where the trend was reversed.

Logistic regression analysis was applied to all these factors and, from this, the only factors that were significantly predictive of full immunisation at two years of age were living in a household where the principal source of income was from a government benefit in the North RHA (adjusted OR= 0.36, 95% CI =0.14, 0.90) and the principal caregiver being under 25 years of age (adjusted OR = 4.29, 95% CI 1.42-12.91) in the North RHA.

2.3.1.7 Recommendations for survey

The study authors recommended the need for enhanced education for caregivers. Firstly, there was a need to improve clear and consistent messages regarding immunisation programmes and more active promotion of the use of immunisations via use of specifically assigned public health professionals at the local and regional levels. Secondly, they identified the need to improve the general level of understanding of appropriate indications/contraindications for the childhood vaccines. Thirdly, they recommended focusing on raising the awareness of the importance of vaccinating on time.

There was also a recommendation to universally institute procedures for routinely sending or telephoning reminder notices to caregivers for upcoming vaccinations and recall notices for overdue vaccination events. To accomplish this, all vaccination providers were encouraged to maintain age/sex registers and keep child immunisation records up-to-date in the child’s record book, at the general practice records, and when transferring between providers.

There was a recommendation to consider enacting legislation requiring caregivers to make explicit choices about immunising their children prior to pre-school or school entry – a *mandatory choice* policy.

The concern around low vaccination coverage levels among children in low-income households was raised, with the related problems of low education achievement, larger family sizes, and high mobility creating what were called ‘high risk’ children. The authors recommended further research into gaining a clearer understanding of this group and the relative importance of various factors that affect their ability to receive immunisation events. A range of other suggestions was given to support this group including targeted promotion, provision of services, and broadening opportunities to vaccinate these children beyond traditional general practice surgeries e.g. via public health nurses in preschool and school, community-based, marae, or church group settings.

The final recommendation was to address the need for regular and reliable information for monitoring the impact of these efforts, preferably via effective immunisation registers or, if that was not occurring, then via periodic repeated surveys.

2.3.2 Northern regional immunisation coverage survey 1996

Primarily in response to mathematical modelling, identifying that another measles epidemic was imminent, the North Health RHA raised the concern that there were still no regular reliable published immunisation coverage data other than the national survey in 1991-1992 (8,42). Therefore, in late 1996, North Health funded an immunisation coverage survey of children residing in their region only (43). This area covers the north of the North Island from North Cape down to Mercer. This survey used the same methodology and a very similar questionnaire to the previous 1991-1992 national survey.

2.3.2.1 Results

In total, there were 775 survey participants in the five North Health sub-regions of Northland, North, West, Central and South Auckland. Of the children surveyed, 19% were Māori. Only 12% of the survey participants in North Auckland were Māori compared with 42% in Northland. Less than 50% of the survey participants were European in Central and South Auckland. Overall, 85% of respondents were the mother of the eligible child (compared with 94% in 1991/92); the average age of the child at interview was three years. Approximately 80% of randomly identified households participated.

Mean household size was 4.9/household which was similar to 1991- 92, but mobility of households had increased. For the region as a whole, 30% of families with children aged two and three were likely to have moved residence twice or more since the birth of that child. In the 1991-1992 survey this figures was 22.4%. There was also a higher number of eligible children born overseas at 8.4%. The number of caregivers able to produce documentation of immunisation from the Health and Development Record Book was 61%, much lower than the 77.3% in the 1991-1992 survey. Up-to-date Health and Development Record Books were 42%, compared to 58.4% in 1991-1992.

2.3.2.2 Attitudes/knowledge

Based on results from the parent/caregiver questionnaire, the expressed importance of the need for childhood immunisation remained high and similar to the 2001-2002 coverage survey, with 85% of parents/caregivers believing strongly in the need for childhood immunisations. Just over two thirds (64%) had a belief that a mild illness, such as a cold, should be a reason for delaying immunisation which was similar to the 1991-1992 national survey. Overall just over one quarter (26%) were unsure of the safety of vaccines and one in five unsure of the rarity of serious side effects. Approximately 60% of Pacific ethnicity and those from ‘Other’ ethnicities indicated that information in their first language would be useful for informed consent. When compared to the NZ European group, both Māori and Pacific respondents were more than twice as likely to be concerned that immunisations were upsetting and painful for young children. This was about 10% higher than when asked in the 1991-1992 survey. Māori and Pacific respondents were also three times more likely to report that the cost of getting to a doctor and travelling and waiting times influenced the decision to immunise their child. There was still a strong belief by 79% (similar to 80% in 1991-1992) that healthcare providers should provide more information on the risks and benefits of immunisation, and 93% supported the value of telephone or written reminders (compared with 89% in 1991-1992).

2.3.2.3 Coverage

Overall, 63% of children were fully immunised by the age of two years. This varied non-significantly across the regions with a trend to lower coverage in Northland and higher in West Auckland. Refer Figure 2.3. Coverage at the age of two was higher for the earlier immunisation events as seen in Table 2.2 and rates of coverage dropped from a high of 89% for the first DTaP event to a low of 60% for the 18 month Hib event. There were non-significant differences across the regions with rates tending to be lower for Northland.

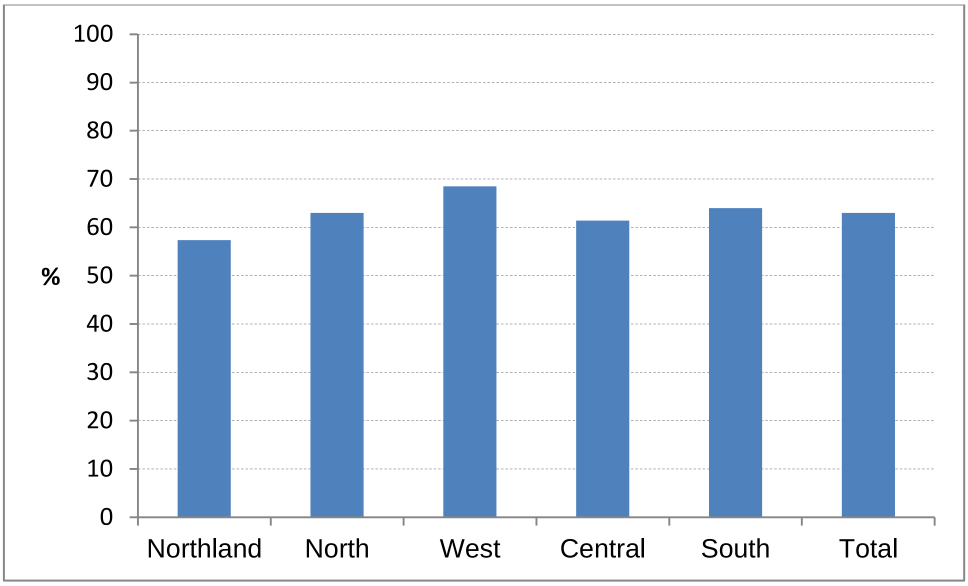

Figure 2.3: Immunisation coverage rates for the schedule vaccines at two years of age by district in the northern region, 1997

Table 2.2: Percentage immunisation coverage rates at two years of age in NZ-born children by sub region, and for the North Health region overall

Vaccination Event	Northland (95% CI)	North (95% CI)	West (95% CI)	Central (95% CI)	South (95% CI)	North Health Total (% rounded)
DTaP 1: 6 weeks	89.2 (85.2-93.2)	87.0 (82.2-91.8)	92.5 (88.0-96.9)	86.4 (81.3-91.4)	90.7 (85.8-95.5)	89
HepB 1: 6 weeks	88.5 (84.5-92.5)	84.8 (79.0-90.6)	91.1 (86.5-95.7)	85.6 (80.3-90.9)	88.0 (82.9-93.1)	88
DTaP 2: 3 months	88.5 (84.7-92.4)	91.3 (87.0-95.6)	93.2 (89.2-97.2)	84.8 (79.5-90.2)	88.7 (82.9-94.4)	89
OPV 1: 3 months	87.2 (83.4-90.9)	89.9 (85.5-94.2)	93.2 (89.1-97.2)	84.8 (79.5-90.2)	87.3 (82.2-92.5)	88
HepB 2: 3 months	88.5 (84.7-92.4)	87.7 (82.9-92.5)	91.1 (86.5-95.7)	84.1 (78.5-89.6)	87.3 (82.3-92.4)	87
DTaP 3 or DTPH: 5 months	83.1 (77.7-88.5)	87.0 (81.4-92.5)	91.8 (87.7-95.9)	84.1 (78.6-89.6)	85.3 (79.9-90.7)	86
OPV 2: 5 months	85.1 (80.4-89.9)	87.7 (83.3-92.0)	93.2 (89.1-97.2)	84.8 (79.6-90.1)	84.7 (78.7-90.6)	87
MMR: 12-15 months	76.4 (70.3-82.4)	81.9 (74.4-89.3)	82.9 (78.0-87.70	78.0 (69.6-86.5)	81.3 (75.6-87.1)	80
HepB 3: 12- 15 months	73.6 (67.1-80.2)	81.2 (73.1-89.2)	81.5 (75.0-88.0)	78.8 (71.5-86.1)	80.0 (74.3-85.7)	79
DT (incl DTPH): 18 months	64.9 (56.7-73.1)	75.4 (66.8-83.9)	71.9 (65.6-78.20	68.2 (59.1-77.2)	72.7 (65.7-79.6)	71
OPV 3: 18 months	64.2 (55.8-72.6)	73.9 (65.2-82.6)	71.9 (65.2-78.6)	68.9 (60.2-77.7)	70.7 (63.2-78.1)	70
Hib (inc DTPH): 18 months	52.0 (42.1-62.0)	66.7 (56.1-77.2)	61.6 (52.6-70.7)	54.5 (46.4-62.7)	62.0 (54.6-69.4)	60

2.3.2.4 Timeliness

Overall, 63% of children were fully immunised by two years of age and this rose to 69% by the time of interview. Refer Table 2.3. There were non-significant differences for the sub regions. There were no other data on timeliness published.

Table 2.3: Immunisation coverage rates, the percentage fully immunised at the age of two years, and at the age of interview in the North Health region 1997

Fully immunised	Northland (95% CI)	North (95% CI)	West (95% CI)	Central (95% CI)	South	Total
By age 2 years	57.4 (48.0-66.8)	63.0 (53.5-72.5)	68.5 (61.4-75.6)	61.4 (52.0-70.8)	64.0 (56.3-71.7)	63
By the time of interview (age 2 - <4yrs)	67.5 (60.5-74.6)	72.5 (64.0-80.9)	75.3 (68.9-81.8)	64.4 (55.1-73.7)	68.0 (60.3-75.7)	69

2.3.2.5 Recommendations

It was recommended that North Health would need substantial further improvements, particularly to their ‘purchasing strategy’, to try to achieve the 1997 immunisation targets. The authors of the report recommended increased focus on enrolment of new-borns before age six weeks; more active use of computerised recall systems; wider understanding of challenges for caregivers in larger families; improving collaboration between healthcare providers – family doctors and immunisation coordinators to improve tracing of infants lost to follow up; a greater focus on upkeep and retention of the Health and Development Record Books and the need to add more emphasis to utilising these as the family record of the immunisation event; and to raise the need to consider the immunisation of new immigrant children.

2.3.3 Using immunisation benefit claims and capitation practice data to measure immunisation coverage

2.3.3.1 Benefit claim data

The Health Funding Authority (HFA) was formed from a merger of the four RHAs in 1997 and was responsible for the funding of public health care in NZ from 1997 to 2001. In 2001, the HFA was disestablished and its roles were picked up by the MoH and 21 new DHBs.

For all non-capitated practices in this period, when a vaccine that was on the national schedule was delivered at the general practice, the practice claimed for reimbursement of the cost of delivery. The claim was then sent in to the northern division of the HFA or to Health Benefits Limited (HBL), a part of the MoH. A change to the benefit claim form in 1994 meant that each dose in the immunisation series was able to be identified, which improved the potential use of these data to report on coverage (8,42,44).

From 9 May 1997, the Northern RHA operated their own immunisation benefit payment system and provider immunisation data for the Northern region cycled directly to the ESR. Following the formation of the HFA, HBL made immunisation payments in the Northern region, but the claims were recorded on a separate database established by the Northern RHA. From July 1998, HBL extracted this data separately and provided it to the ESR.

2.3.3.2 Capitation data

Capitated payment systems are based on giving a payment per person, rather than a payment per service provided. General practices working under a capitation system were given a sum per registered patient that had the immunisation benefit within the total figure and therefore did not use a claim form for vaccinations delivered. Immunisation coverage figures for capitation practices were obtained in a range of ways. Over this time period the number of capitated practices was reported as increasing, although there was no clear figure on what percentage of practices overall were capitated or what percentage were regularly reporting their immunisation coverage data.

Southern region: The Pegasus and Selwyn Medical groups, which comprised the ‘majority’ of capitation practices in the Southern division of the HFA, provided data on the number of immunisations administered directly to the ESR. Other Southern region capitation practices provided data via the Southern division of the HFA.

Central region: Immunisation coverage data were provided via the Central division of the HFA. The number of children under two years of age in capitation practices in this region was given as very similar in both 1997 and 1999, but much lower in 1998, which was suggestive of the 1998 data being incorrect.

Midland region: It was estimated that in March 1996, capitation practices in the Midland region included approximately 20% of the regions under one-year-old age group (42). From January 1998, data coverage from these practices was supplied via HBL; prior to this data were not easily obtainable from these practices and therefore making these data unreliable (44).

Northern Region: Data were collected via the Northern division of the HFA.

2.3.3.3 Calculation of immunisation coverage rates

Immunisation coverage was calculated by combining the benefit claim data with the data from the capitated practices. Coverage was reported by antigen, received within a month of the recommended timing of the vaccine.

2.3.3.4 Limitations of these data

A new immunisation schedule was introduced on 26 February 1996 which changed the timing of administration and composition of a number of the vaccinations (35). This made it difficult to calculate coverage levels for some of the antigens during 1996 and 1997.

Data collected from claims were reliant on all vaccine events that were being given having also had a claim form submitted for payment. There were no quality checks on what percentage of vaccinations given in the country was claimed for at the time; hence, there was no way of verifying the accuracy of using claim data for reporting purposes. Furthermore, the data were collected from a range of sources originally intended for purposes of payment to practices, not accuracy in vaccine event counting. Capitation practice data were mostly collected via practices reporting coverage data from their general practice records to the local divisions of the HFA.

There is no information on how complete this data set was. Additionally, as can be seen above, there were many different ways of collecting data from capitated practices and the accuracy of the childhood populations submitted with these data used for the denominator is unclear.

Another concern with these data included the lack of information on the number of general practices completing the benefit claims forms. There is also no quality checking information available on the data entry and retrieval in the HBL and North Health databases. All regions were required to provide the number of children who were no longer in practices that claim immunisation benefit data and ideally, all the practices that did not claim immunisation benefits were required to provide immunisation figures to HBL or the ESR, but there was no systemic way of checking how complete that was.

2.3.3.5 Estimated coverage rates using benefit data and capitation practice data

Based on the data collection described above, coverage rates were reported for 1996, 1997 and 1998. These were calculated using birth cohorts and census-based population denominators. However, with the new immunisation schedule started in 1996, changes were made to simplify the schedule by dropping the 18 month visit. This resulted in a transition period between the two schedules; different age cohorts often received the same vaccination. Therefore the coverage levels for the 1996-1997 transition periods are not considered to be accurate.

Table 2.4: National immunisation coverage for 1995-1998 based on benefit claim and capitation practice recorded data

Vaccination	Recommended Timing (from Feb 1996)	1995 (%)	1996 (%)	1997 (%)	1998 (%)
DTPH1	**6 weeks**	88.4	92.1	85.5	82.1
DTPH2	**3 months**	88.8	91.3	86.6	81.3
DTPH3	**5 months**	88.7	90.6	87.3	81.3
DTPH4	**15 months**	74.9	76.7	95.1	78.7
HepB1	**6 weeks**	86.9	92.6	90.4	83.7
HepB2	**3 months**	87.8	93.4	90.3	83.0
HepB3	**5 months**	83.2	69.5	104.2	86.7
OPV1	**6 weeks**	87.2	95.5	86.3	83.4
OPV2	**3 months**	87.4	94.9	87.4	81.2

Vaccination	Recommended Timing (from Feb 1996)	1995 (%)	1996 (%)	1997 (%)	1998 (%)
OPV3	**5 months**	82.2	86.0	117.2	82.3
MMR1	**15 months**	84.3	87.4	113.8	71.9
MMR2	**11 years**	-	52.2	243.9	22.6

Table 2.5: Immunisation coverage for 1996-1998 for the HFA regions based on benefit claim and capitation practice recorded data

Vaccine	**Recommended Timing**	**Northern HFA (%)**			**Midland HFA (%)**			**Central HFA (%)**			**Southern HFA (%)**		
		1996	1997	1998	1996	1997	1998	1996	1997	1998	1996	1997	1998
DTPH1	**6 weeks**	95.2	83.5	77.9	86.3	81.2	83.0	91.9	91.3	83.9	92.0	86.9	87.8
DTPH2	**3 months**	92.3	83.1	76.1	86.3	82.0	82.7	92.8	93.4	82.6	92.2	89.9	89.2
DTPH3	**5 months**	87.8	82.0	74.8	88.8	83.9	84.8	94.6	96.2	81.7	93.4	90.7	89.7
HepB1	**6 weeks**	95.0	89.8	79.6	86.7	82.1	83.5	93.6	94.7	86.9	92.5	93.8	88.9
HepB2	**3 months**	94.3	89.1	78.1	87.1	83.3	83.3	95.2	97.6	84.9	95.8	90.6	90.8
MMR1	**15 months**	85.4	109.3	67.3	84.4	123.7	75.4	88.6	116.0	66.1	92.9	112.2	72.4
MMR2	**11 years**	167.1	18.3	32.9	247.6	21.6	32.9	32.9	228.5	17.7	113.1	397.8	36.9

Notes on the above two tables:

**Monovalent Hib was administered during 1995 and the first quarter of 1996*

For HepB3, OPV1, OPV2 and OPV3 the age groups varied during the transition period of the new schedule introduced in 1996

For MMR1 and MMR2 coverage has been inflated because of the national measles vaccination campaign held in 1997. There was also a substantial number of MMR2 vaccinations administered outside general practice, with payments not made via HBL and hence not captured in this data. 1998 MMR 1 figures were underestimated due to data entry errors and re-corrected in a 1999 report (44).

2.3.3.6 Conclusions from immunisation benefit / capitation data

Comparisons cannot be made with the MMR coverage for 1997 as the figures were inflated by the enhanced MMR immunisation programme to control a measles epidemic.

Overall coverage levels for 1998 appeared lower than for the previous two years, and the Ministry reported an estimated reduction of 10 percentage points for coverage overall in 1998 compared to 1996. Furthermore there was a reported drop in coverage for the last quarter of 1998, compared with the first three quarters. Data reported from the first quarter of 1999 showed some improvement from 1998 but were still well below what were reported in 1996 (44).

Table 2.6: Immunisation coverage rates based on benefit claim and capitation practice records, comparing the last quarter of 1998 with the annual figures for 1996 for three different vaccines

Vaccination	Recommended Timing	1998 Last Quarter (%)	1999 First Quarter (%)	1996 Total (%)
DTPH3	**5 months**	76.4	85.1	90.6
HepB2	**3 months**	78.0	84.6	93.4
OPV3	**5 months**	76.7	84.5	81.2
MMR1	**15 months**	71.9[1]	77.2	87.4

Note 1. Corrected figure for MMR1 for all of 1998 has been taken from the 1999 Ministry coverage report (44)

The majority of the decline in coverage for 1998-1999 was in the Central and Northern regions. However it is not clear whether this was due to a genuine decline in coverage or lack of reliable data. The MoH report particularly highlighted concerns that this reduction in coverage may have been due to poor data collection for the children attending capitated practices in these regions. The number of children attending capitated practices was unknown but capitated practices reported them as increasing.

2.3.3.7 Concerns and recommendations based on reporting of coverage rates using benefit claims data

In my role in 1999 as the Medical Director of the IMAC, University of Auckland, I wrote a short report for the MoH in response to the reported immunisation rates suggesting that coverage rates may be dropping.

The concerns at this time listed by myself were:

I. In 1999, NZ was due for another pertussis epidemic, predicted to arrive any time from late 1999. Hence, obtaining high immunisation coverage and timeliness of delivery was of importance.

II. Another measles epidemic could arise in the next 2 to 3 years if immunisation coverage levels remained low.

III. Lack of an accurate measuring and monitoring mechanism for immunisation rates and an inability to track unimmunised children.

IV. Low immunisation rates in NZ compared to most other Western countries and many developing countries.
V. NZ could continue to re-infect the Pacific with VPDs such as measles.

The reasons behind immunisation rates were reported in two broad groups:

- Factors related to socio-economic deprivation leading to lack of registration with a regular doctor, very mobile families, barriers to accessing general practice, including costs, and difficulties in tracking these families with no integrated databases.
- Community confidence in immunisation, particularly lack of awareness of the diseases and fear of vaccine-purported side effects.

I recommended three solutions:

I. Every child to be registered with a general practice and, when they move, registration necessarily to be moved with them.
II. The need for a comprehensive national system (a national register) to provide reliable national data and to be able to track children missing out on services.
III. More widespread use of the Well Child Health and Development Record Book, both with caregivers and healthcare professionals.

2.3.4 National immunisation coverage survey 2005

In recognition that since the last national survey in 1991-1992 there were no other reliable and robust national measures of immunisation coverage, a further survey was commissioned by the MoH and undertaken in 2005 (45). The aims of this survey were to provide an accurate baseline estimate of coverage levels, to measure any changes since 1991-1992, and to gather information on caregiver attitudes to immunisation in order to be able to inform and to design strategies to improve immunisation coverage. The survey was funded by the NIP within the MoH which contracted the National Research Bureau to design and undertake the survey.

The survey methodology was based on the methodology used in 1991-1992 and the regional 1995-1996 surveys. The difference from 1991-1992 was a larger sample size and stratification was used to enable statistical significance for Māori and Pacific children. Two separate strata were identified: stratum 1 was mesh blocks containing Pacific peoples at a density of 10% or more, and stratum 2 was mesh blocks containing Pacific peoples at a density of less than 10%.

2.3.4.1 Results

2.3.4.1.1 Results: Participant characteristics

There were 1563 household respondents, of whom the child was Maori for 28.1%, Pacific for 11.3%, Asian for 7.5% and European for 52.7%. The average age of the children was three years (2.96 years with 95% CI 2.93-2.99). Overall around 40% of households were in the lowest income bracket (defined as $40,000 or less), with 71% of Pacific, 59.1% of Māori and 52.9% of Asian ethnicity, which were all more likely than European/other households (28.9%). One third of all households (33.9%, 95% CI 30.7-37.1%) had moved on two or more occasions, with children from Māori households significantly more likely to have moved (45.7%, 95% CI 38.8 – 56.2%) than European or Asian children. There was no significant difference between Māori and Pacific children.

2.3.4.1.2 Results: Attitudes and knowledge

Over 80% of caregivers agreed that all childhood immunisations are important, that vaccines are effective in stopping children from catching diseases, immunisation is available free for all children, and felt that a reminder when immunisations are due would be useful.

Over 50% of caregivers (52.4%, 95% CI 49.6-55.3%) believed that immunisation can cause serious side effects, although 76.7% (95% CI 74.4-78.9%) believed these were rare. Caregivers of European/other children were more likely to agree with the statement that immunisation can cause serious side effects (59.0%, 95% CI 55.2-62.8%) than those of other ethnicities.

Approximately 30% (29.1%, 95% CI 26.1-32.0%) of caregivers believed that immunisation was too upsetting or painful for young children. Nearly 60% (58.7%, 95% CI 55.7-61.6%) of caregivers believed that children should not be taken for immunisation if they have any illness, even a mild cold. Caregivers of European/other children were more likely to agree with this (63.3%, 95% CI 59.4-67.2%) than caregivers of Pacific (44.9%, 95% CI 35.0 – 54.9%) or Asian (45.7%, 95% CI 37.6-53.8%) children.

Nearly 20% (19.0%, 95% CI 16.6-21.4%) of caregivers identified that travelling and waiting times contribute to making immunisation completion difficult. This was less likely to be identified as a problem by caregivers of European/other children (12.4%, 95% CI 9.8-15.0%) compared to other ethnic groups.

2.3.4.1.3 Results: Coverage

This style of survey may report more conservative coverage estimates because only those children with written documentation of having received a vaccination (either through the Health and Development Record Book or verified written records via the general practice) were accepted as vaccinated. However when compared with vaccinator-recall of immunisation, there was no significant increase in coverage levels with the proportion of children fully immunised at the time of the survey increasing from 82.7% (95% CI 80.7-84.6) to 83.05% (95% CI 81.0 – 85.0). Refer Table 2.7.

By two years of age, 77.4% of children were fully immunised (95% CI 75.3-79.5%). Māori children were less likely to be fully immunised (69%, 95% CI 63.7-74.3%) than European/other children (80.1%, 95% CI 77.4-82.9%). While not statistically significant, Pacific children had the highest coverage rates at 80.7% (95% CI 73.7-87.6%). There were no significant differences when data were aggregated into the four health regions, although there was a non-significant trend of improving coverage for the South region. Refer Figure 2.4. There is a trend for decreasing coverage for each successive dose of an individual vaccine. However the only significant decrease in vaccine coverage was for the 15 month vaccination event for DTaP and Hib.

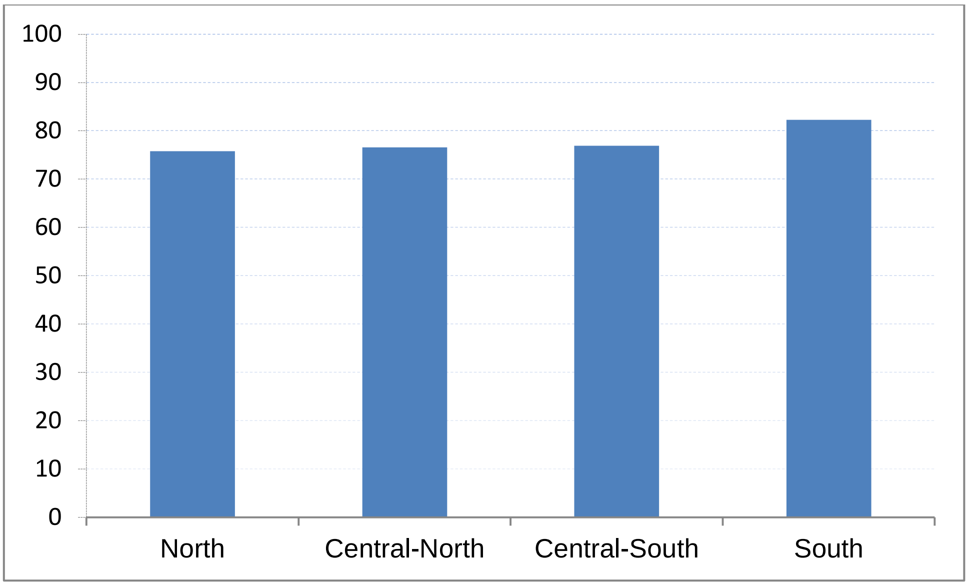

Figure 2.4: Immunisation coverage rates for the schedule vaccines at two years of age by Regional Health Authority, 2005

2.3.4.3 Timeliness

To determine whether vaccination events were given on time, the time period between the date of vaccination and the child's date of birth was compared to the age in days the scheduled vaccine was given in days. A vaccine was determined to be 'on time' when the age the child received the vaccine was within thirty days of the recommended age of vaccination. One problem that was recognised with using this definition for on-time was that if an initial vaccine is given late, then most of the subsequent vaccines may also be late to allow for the correct time interval between vaccine doses. The study investigators decided to calculate the interval between sequential doses from the immunisation schedule and they produced an 'interval-adjusted on-time dose' which was a calculation of the interval between sequential doses from the immunisation schedule. An interval-adjusted on-time dose required the vaccine to be given within 30 days of the recommended interval between sequential doses.

Table 2.7 demonstrates coverage rates for the national schedule vaccines at different time points: one year of age; two years of age; at the time of survey (the child aged from two years to less than four years); and a measure of coverage on time for all immunisation events. By the time of interview (any age from two to the fourth birthday) coverage levels had increased by just over 5% nationally. There was a trend towards higher coverage and timeliness of delivery in the southern regions; however numbers for any single DHB are small, giving wide confidence intervals (CIs).

Table 2.7: The percentage immunisation coverage (and 95% confidence intervals) at different end points, by DHBs (reproduced from Table A3-3 The National Immunisation Coverage Survey 2005)

Region (by DHB)	Coverage at age 1 year	Coverage at age 2 years	Coverage at Time of survey	Coverage on time	Coverage on time (adjusted)
National	82.1 (80.0-84.3)	77.4 (75.3-79.5)	82.6 (80.6-84.6)	39.0 (36.3-41.6)	42.4 (39.7-45.1)
Auckland	86.1 (80.0-92.3)	78.0 (71.5-84.5)	84.1 (77.7 -90.5)	42.1 (34.6-49.6)	43.1 (35.2-50.9)
Bay of Plenty	78.6 (67.3-89.9)	76.2 (65.2-87.1)	85.8 (79.0-92.5)	28.5 (15.9-41.1)	31.0 (18.1-44.0)
Canterbury	88.1 (82.5-93.6)	80.7 (73.4-88.1)	84.4 (78.0-90.9)	45.5 (35.3-55.8)	48.3 (38.7-57.8)
Capital and Coast	81.4 (72.0-90.8)	75.5 (64.3-86.7)	80.4 (71.1-89.7)	38.4 (29.3-47.4)	44.1 (34.4-53.8)
Counties Manukau	82.1 (76.8-87.4)	76.3 (68.8-83.8)	81.5 (74.8-88.2)	38.3 (30.0-46.6)	45.0 (37.8-52.2)
Hawkes Bay	81.1 (70.8-91.4)	72.9 (59.7-86.0)	75.4 (63.5-87.2)	35.3 (23.0-47.6)	38.6 (26.9-50.4)
Hutt	87.9 (79.9-96.0)	82.3 (72.3-92.3)	87.1 (78.8-95.4)	38.8 (18.5-59.1)	41.3 (21.3-61.4)
Lakes	85.6 (78.9-92.3)	84.6 (67.7-100.0)	87.6 (74.1-100.0)	44.8 (33.9-55.7)	46.7 (36.1-57.2)
MidCentral	86.1 (77.1-95.0)	86.2 (77.0-95.4)	91.2 (82.8-99.7)	44.4 (24.2-64.7)	47.9 (30.1-65.8)
Nelson Marlborough	85.0 (70.2-99.8)	80.7 (63.2-98.3)	84.8 (73.8-95.7)	49.7 (35.0-64.3)	55.7 (41.8-69.7)
Northland	71.2 (54.0-88.3)	64.9 (49.5-80.3)	77.0 (64.8-89.2)	21.7 (8.5-34.8)	25.6 (14.1-37.1)
Otago	73.5 (58.9-88.2)	74.2 (60.2-88.1)	78.1 (64.3-92.0)	43.0 (30.8-55.2)	46.8 (33.6-60.0)
South Canterbury	93.7 (80.6-100.0)	93.7 (80.6-100.0)	93.7 (80.6-100.0)	-	-
Southland	94.5 (88.9-100.0)	88/9 (82.2-95.6)	94.5 (88.9-100.0)	49.4 (36.3-62.4)	55.6 (39.7-71.7)
Tairawhiti	78.3 (33.0-100.0)	64.3 (41.1-87.4)	76.1 (48.3-100.0)	-	-
Taranaki	87.4 (77.9-96.9)	83.7 (70.8-96.5)	85.6 (74.3-96.9)	48.7 (34.0-63.5)	52.7 (36.5-68.9)
Waikato	75.8 (67.3-84.2)	72.2 (62.9-81.5)	80.0 (70.6-89.4)	37.6 (26.5-48.7)	40.1 (29.6-50.6)
Wairarapa	81.0 (63.0-99.0)	72.8 (50.1-95.5	72.8 (50.1-95.5)	-	41.3 (19.6-63.1)
Waitemata	78.1 (70.2-86.0)	76.9 (68.7-85.0)	80.6 (72.0-89.3)	36.5 (28.9-44.0)	37.2 (29.8-44.6)
Whanganui	63.0 (39.4-86.7)	55.2 (38.0-72.4)	60.5 (35.5-85.5)	-	-

NB A dash (-) indicates results were not provided because the count was <10

West Coast DHB numbers were too low to be significant so are not included in this table

2.3.3.4 Reasons for missed immunisations

At the time of the survey, 17.2% (n=269) of the children surveyed had missed one or more vaccination events, and 93% (n=250) of the caregivers provided reasons for this. The four most frequently identified reasons for missed immunisations were:

I. Concerns about the risks associated with vaccination (25.2%, 95% CI 19.4-31.0%).
II. Use of a different immunisation schedule or vaccination undertaken overseas (19.1%, 95% CI 13.4-24.7).
III. A caregiver-identified medical reason (11.0%, 95% CI 6.8-15.2%).
IV. A belief that the child had been vaccinated but this was not confirmed by the records (8.1%, 95% CI 4.7-11.6%).

There were no significant differences between the ethnic groups except for Asian caregivers having much lower concerns around the risks associated with immunisation (6.6%, 95% CI 0 – 20.0) compared with Maori (23.9%, 95% CI 11.6-36.2%) and European/Other (29.2%, 95% CI 21.3-37.2%). Numbers were too small for Pacific caregivers to provide data here. Missed vaccinations for children of Asian caregivers were most commonly due to use of an overseas immunisation schedule rather than any other reason (57.9%, 95% CI 34.5-84.1%). The only significant difference in the regions was the Central-Northern region, where the risk associated with immunisation (38.3%, 95% CI 22.0 – 54.6%) was more likely to be the explanation given for incomplete immunisation that other reasons.

2.3.4.5 Factors associated with incomplete immunisation

A univariate analysis undertaken looking at the association of variables on the immunisation status of the child at two years of age identified the issues listed below.

Household income: Principal income from a benefit decreased the likelihood of full immunisation by almost half (OR 0.53, 95% CI 0.36-0.78). Lower household income (≤ $40,000) was associated with a significant lowering of the likelihood of being fully immunised at age two years (OR 0.60, 95% CI 0.42-0.8), compared with households with incomes over $70,000.

Socioeconomic deprivation: The small area socioeconomic deprivation measure based on the NZ 2001 Deprivation Index (46) was used as a measure of deprivation. Using the least deprived quintile as the reference group, children living in quintile four had a reduced odds ratio (OR) of being fully immunised (OR 0.57, 95% CI 0.37-0.88). This relationship was not significant for the most deprived quintile, quintile five.

Ethnicity of the principal caregiver: When the caregiver identified as Māori, compared to the reference group of non-Māori, there was significantly less likelihood that the child would be fully immunised at two years of age (OR 0.53,95% CI 0.39-0.71).

Household mobility: Children from households who had moved on two or more occasions since the child was born were less likely to be fully immunised at two years of age (OR 0.43, 95% CI 0.32-0.58).

Age of the principal caregiver: When the principal caregiver was less than 25 years of age, the child was less likely to be immunised at two years of age (OR 0.63, 95% CI 0.41-0.98). There was no significant difference for immunisation status with caregivers older than 25 years.

Living status of the principal caregiver: Children with a caregiver living alone were less likely to be immunised at two years of age (OR 0.61, 95% CI 0.38-0.97).

Education level of the caregiver: Children with a caregiver with no formal school or other qualification were less likely to be fully immunised at two years of age (OR 0.64, 95% CI 0.46-0.89).

From these variables, the six most significant, based on these findings and the international background literature, were chosen to include in a multivariable model: total household income, caregiver qualifications, number of household moves since the child's birth, caregiver age, caregiver ethnicity, and caregiver living status. Logistic regression was undertaken. From this analysis, two variables remained significant in lowering the OR of a child being fully immunised by the age of two years: two or more household moves since the birth of the child (OR 0.46, 95% CI 0.33-0.64), and the ethnicity of the principal caregiver being identified as Māori (OR 0.60, 95% CI 0.41-0.87).

2.3.4.6 Comparative findings from the coverage surveys of 1991-1992, 1995-1996 and 2005

Some interesting trends can be seen in differences between the three coverage surveys. Refer Table 2.8. Of note is that there appears to be more mobility in households over time. Caregiver belief in the importance of immunisation appears to have reduced over time, with a parallel increasing proportion of those believing that if a child was healthy they did not need immunisation. Caregiver knowledge appears to have improved over time, with some reduction in the number of caregivers who would delay immunisation because of a mild illness (a false contraindication).

Table 2.8: Comparative results between the coverage surveys of 1991-1992, 1995-1996 and 2005

Year	**1991-1992**	**1995-1996**	**2005**
Region	National	Northern	National
Number of households surveyed	706	775	1563
Year	1991-1992	1995-1996	2005
More than two household moves since the birth of the child	22.4%	30%	33.9%
Caregiver belief in the importance of childhood immunisation	90%	85%	80%
Caregiver belief that immunisation unnecessary if a child is healthy	2-8%	7.5%	19%
Caregiver belief that a mild illness would be a reason to delay an immunisation even	68%	64%	58.7%
Significant predictive factors for under immunisation	Living in a house hold where the principal source of income was from a benefit Principal caregiver <25 years	Delayed start to programme Ethnicity of principal caregiver: Maori or Pacific Later birth order in family High mobility of families	High mobility of families Ethnicity of principal caregiver Maori

2.4 Recording immunisation coverage reporting 2005 – 2012: The National Immunisation Register

The National Immunisation Register (NIR) was introduced as part of the rollout of a meningococcal B vaccination campaign to control an epidemic of a strain-specific meningococcal B disease. The vaccine was tailor-made for the NZ-specific strain and was rolled out in NZ progressively from mid-2004, starting initially in the region of Counties-Manukau DHB (as this was the region with the highest burden of disease) and from there progressively being introduced to the Northern areas and over 2005 to other DHBs moving southwards.

There had been a strategic intent to introduce an NIR for some time. However the implementation was prioritised because of the need to monitor the safety and implementation of the MeNZB^{TM} vaccine. Because this vaccine was designed for the NZ market, it required intensive post-market surveillance. A national register was part of the requirement for the roll-out. The NIR was first implemented in Counties Manukau in mid-2004 with the rollout of the meningococcal B vaccination campaign, then progressively throughout the country from 2005.

2.4.1 National Immunisation Register (NIR) data from 2006 – 2012

2.4.4.1 Fully immunised by milestone ages

Data have been reported online regularly since 2009. Earlier data are available from the NIR on request. Because children were entered onto the NIR from birth, starting from 2005, coverage data were only available in 2006 for the milestones at 6 months and 12 months of age and for older ages from 2007.

Figure 2.5 illustrates coverage rates for four different age groups from six months to two years of age. There was steady improvement in immunisation coverage at twelve months and at two years of age, highlighting consistent progress during this era in coverage rates. Timeliness of delivery can be seen when looking at how many are fully immunised at six months (one month after the third vaccination event) and 18 months (three months after the fourth vaccination event) of age. Timeliness of vaccination is clearly well behind fully immunised when looking at the milestone ages of twelve months and two years, but continual improvement is also seen. However, as can be seen in Figure 2.6, improvements in coverage, particularly at the milestone age of two years, occurred until around 2011 when it levelled off. Improvement in timeliness of delivery has shown particular improvement since 2011.

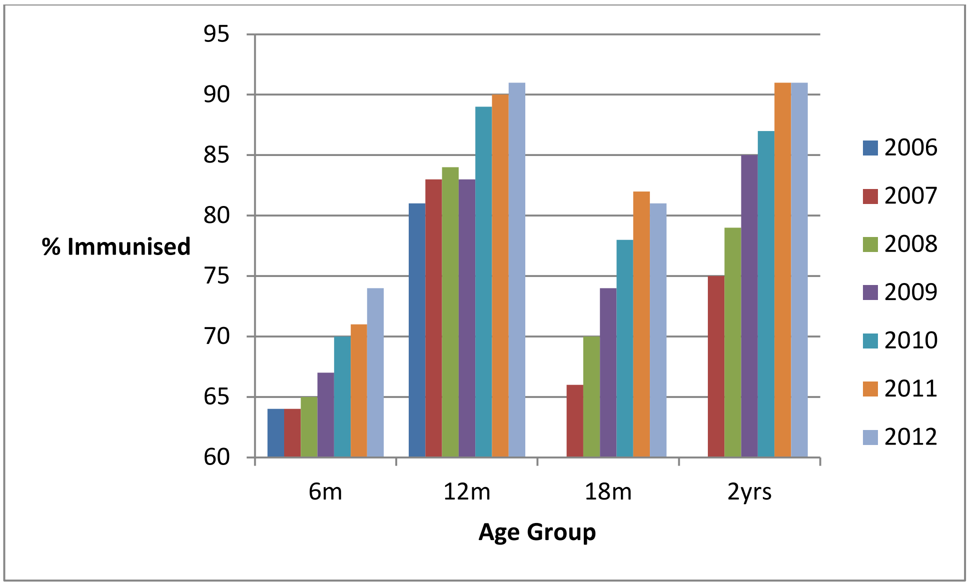

Figure 2.5: NIR data from 2009 to 2012 showing national immunisation coverage rates at ages 6 months, 12 months, 18 months, and 2 years of age

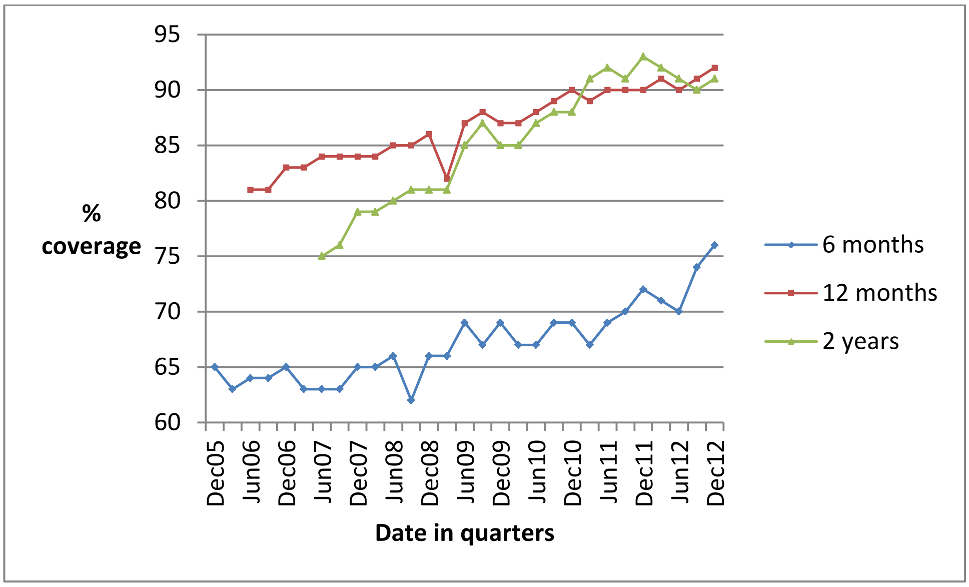

Figure 2.6: NIR data from December 2005 to end 2012 showing national immunisation coverage rates by 3 monthly reporting at ages 6 months, 12 months and 2 years of age

2.4.1.2 Fully immunised by ethnicity

There are significant equity gaps for immunisation coverage across different ethnic groups with Māori and 'Other' having markedly lower coverage rates than other groups. This gap had closed considerably by 2012, although differences still remain. The group 'Other' mostly consists of immigrant children, including refugees. Reasons for low coverage in this group are likely to be diverse. Describing the group is difficult because different countries of origin means different immunisation schedules need to be matched to the NZ schedule, alongside challenges with healthcare access for refugee children in particular. Refer Figure 2.7.

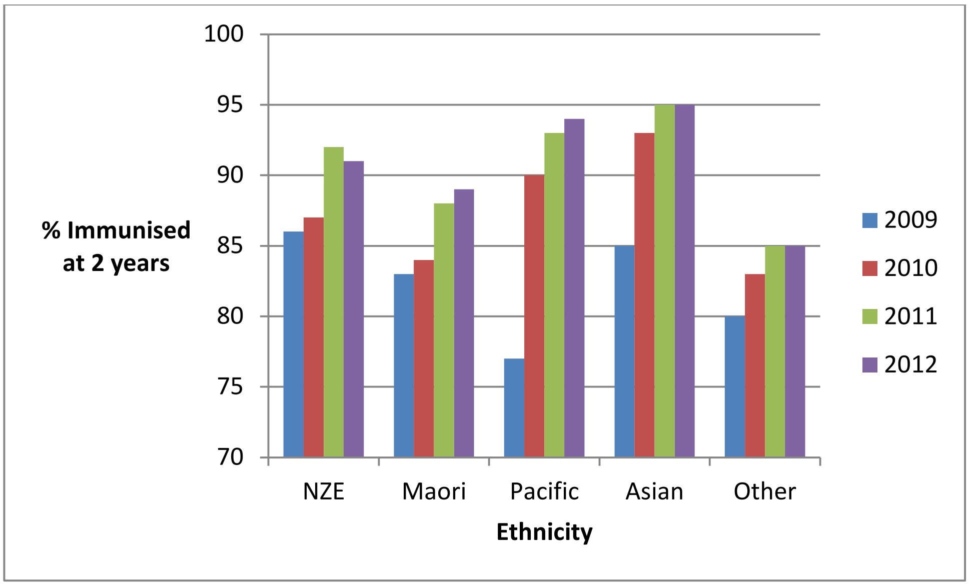

Figure 2.7: NIR data from 2009 to 2012 showing national immunisation coverage rates at 2 years of age by ethnicity

2.4.1.3 Fully immunised by socioeconomic status

There are also significant equity gaps for immunisation coverage across different socio-economic groups, with children from the poorest areas in particular showing markedly lower coverage rates than those from wealthier areas as measured by the NZ Deprivation Index (6). This gap had closed considerably by 2012, although small differences still remain. Improvements in coverage were greater for those children from the lower socioeconomic backgrounds (quintile 9-10) than for the others. Refer Figure 2.8.

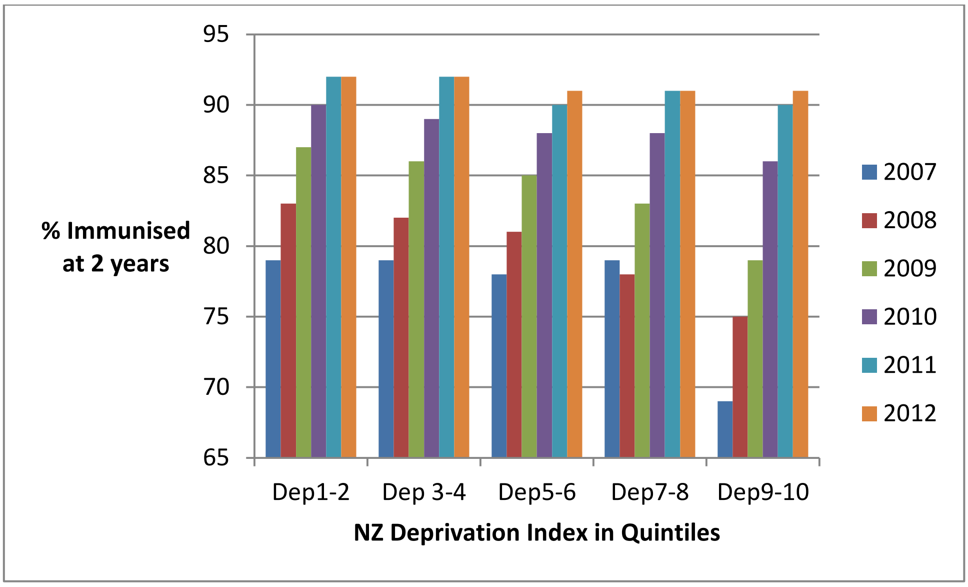

Figure 2.8: NIR data from 2009 to 2012 showing national immunisation coverage rates at 2 years of age by the NZ Deprivation Index in quintiles

2.4.1.4 Fully immunised by region

Data have also been reported by DHB and show significant variations in different regions as shown in Figure 2.9 reproduced from page 23 of the 2010 *Immunisation Coverage and Vaccine Preventable Diseases* report from the IMAC, University of Auckland (47).

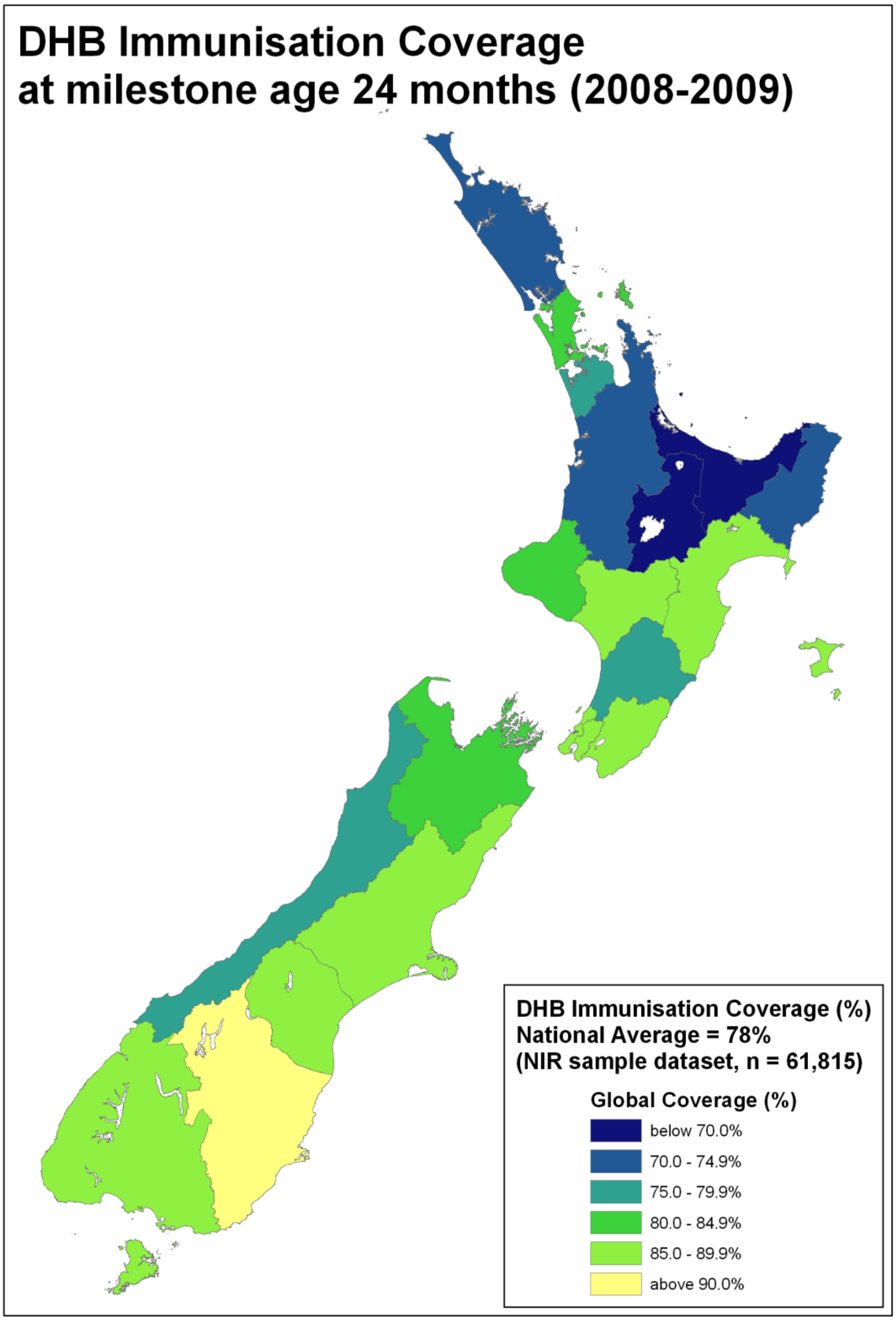
DHB Immunisation Coverage
at milestone age 24 months (2008-2009)
DHB Immunisation Coverage (%)
National Average = 78%
(NIR sample dataset, n = 61,815)
Global Coverage (%)
below 70.0%
70.0 - 74.9%
75.0 - 79.9%
80.0 - 84.9%
85.0 - 89.9%
above 90.0%

Figure 2.9: Fully immunised at 2 years of age mapped by DHB using NIR data for 2008-2009

While the general national trend is for the highest deprivation quintile to have the lowest immunisation coverage, there is considerable variance between DHBs. For example, in 2009 this was reported by the IMAC report page

22. Refer Figure 2.10. The most recent data show reduced, although still marked, variation across DHBs. Refer Figure 2.11.

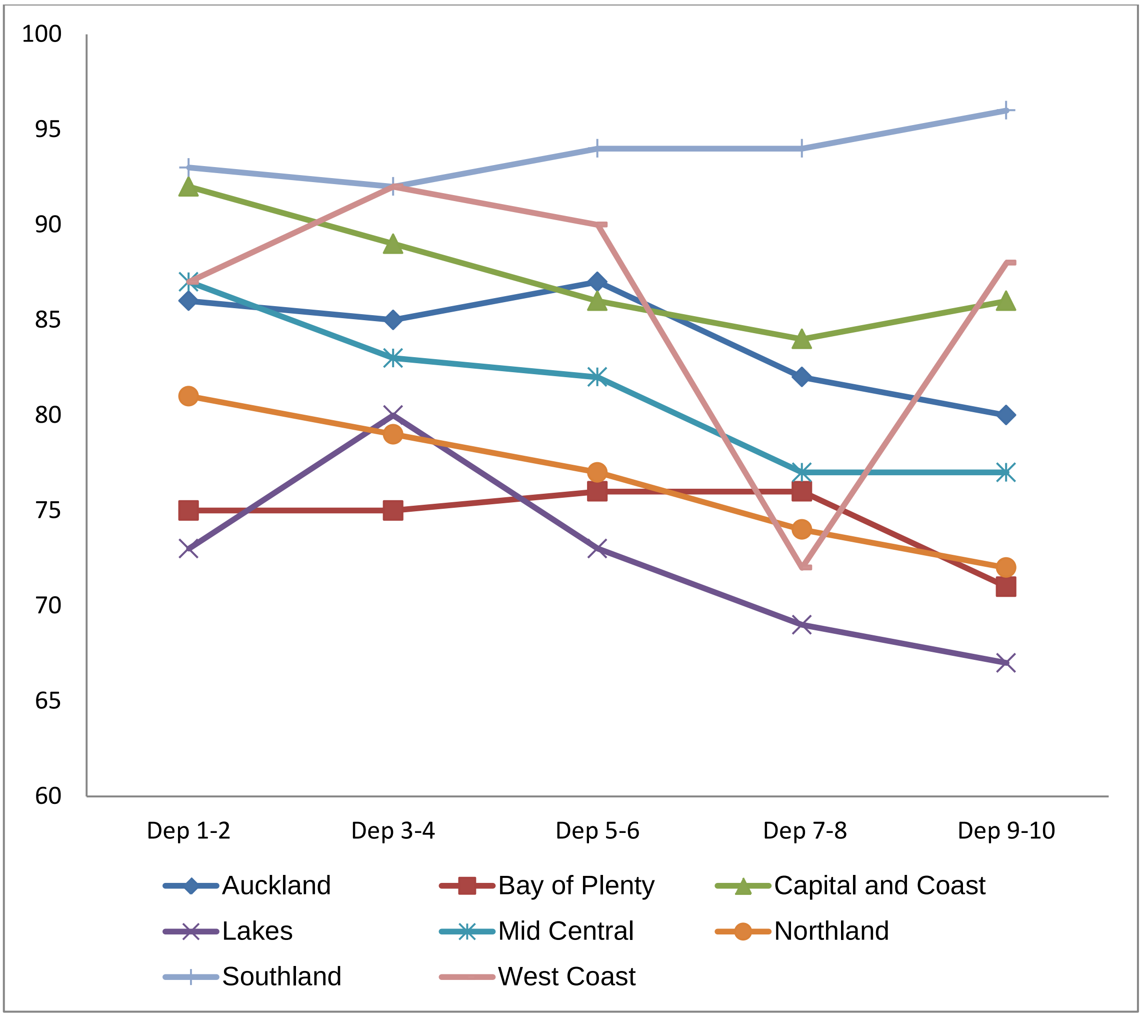

Figure 2.10: Immunisation coverage for 2009 in selected DHBS measured by NZ deprivation in quintiles

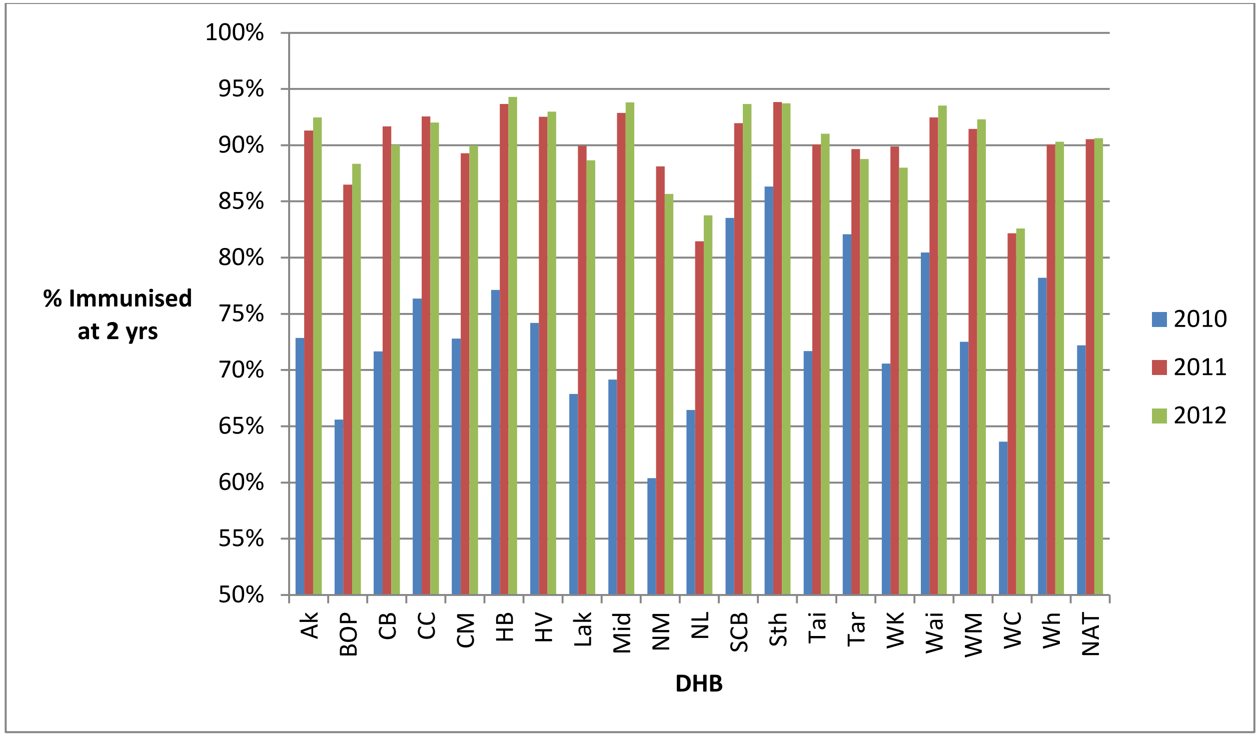

Figure 2.11: Immunisation coverage for 2010 – 2012 measuring fully immunised at 2 years of age by DHB using NIR data

Key to DHBs:

Ak	Auckland	**BOP**	Bay of Plenty	**CB**	Canterbury	**CC**	Capital and Coast
CM	Counties Manukau	**HB**	Hawkes Bay	**HV**	Hutt Valley	**Lak**	Lakes
Mid	MidCentral	**NM**	Nelson Marlborough	**NL**	Northland	**NAT**	National
SCB	South Canterbury	**Sth**	Southern	**Tai**	Tairawhiti	**Tar**	Taranaki
WK	Waikato	**Wai**	Wairarapa	**WM**	Waitemata	**WC**	West Coast
Wh	Whanganui						

2.4.1.5 Timeliness of delivery

Timeliness of delivery has improved significantly, with coverage measured at six months of age being 65% nationally in 2006 and 76% at 2012. Refer Figure 2.5.

In response to the national target, from 2012 the NIR has been reporting the proportion of children fully immunised at 8 months of age. As shown in Figure 2.12, there were marked equity gaps, particularly for Māori children, who have 78% coverage compared to NZ European children at 90% and for children from the lowest deprivation quintile (NZ Dep 9-10) at 82% coverage, compared to those from the highest quintile (NZ Dep 1-2) on 90% timeliness at eight months.

If the measurements at eight months of age are used, the equity gap is even more marked with Māori children at 60% immunised, Pacific 72%, NZ European 80% and Asian 87%. Children from the lowest NZ deprivation quintile (NZDep 9-10) are 65% immunised at six months compared to 80% for those from the highest quintile (NZ Dep 1-2). Refer Figure 2.12.

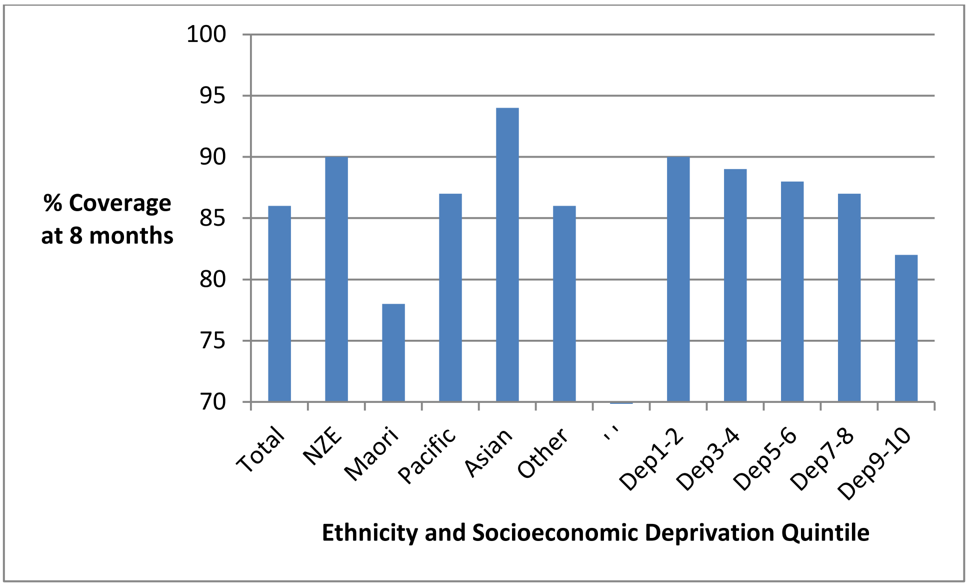

Figure 2.12: NIR data for 2012 showing national immunisation coverage rates at eight months of age by ethnicity and the NZ Deprivation Index in quintiles

2.4.2 Summary of immunisation coverage from 2007 – 2012 based on NIR data

NIR data have enabled regular monitoring of progress with immunisation coverage since 2007. This has shown consistent progress in coverage rates, as seen at twelve months and at two years of age. Improvement in timeliness of delivery has lagged behind coverage, but has shown particular improvement since 2011 when coverage rates started levelling off. Equity gaps across ethnicities and socioeconomic divides closed considerably by 2012, although differences still remained, particularly for timeliness of delivery. Improvements in coverage were greater for those children from the lower socioeconomic backgrounds than from others. There still remain significant variations in different regions, and while the general national trend is for the highest deprivation quintile to have the lowest immunisation coverage, there is considerable variance between DHBs. Timeliness of delivery has improved significantly, with coverage measured at six months of age being 65%

nationally in 2006 and 76% at 2012. There are marked equity gaps, particularly for Māori children, who have 78% coverage compared to NZ European children at 90% and children from the lowest deprivation quintile (NZ Dep 9-10) at 82% coverage, compared to those from the highest quintile (NZ Dep 1-2) on 90% timeliness at eight months.

2.5 National policy and strategies around immunisation coverage

2.5.1 Public Health Commission Report 1993

The Public Health Commission was established in 1993 to "conserve and improve the population's health" and was overall responsible for health monitoring, public health policy advice and the purchase of public health services (48). In 1993 the government announced six pilot health goals, one of which was increasing immunisation coverage (49): *To increase to 80% by the year 1995, and to 90% or more by the year 2000 the proportion of NZ children with completed early childhood immunisation by the time they are two years old.*

Based on the gap between the immunisation coverage rates identified in the 1992 national survey (5), the Public Health Commission convened an expert working group in 1993 to assist in the development of a national immunisation strategy (50). The recommendations from this report were:

I. Appointing local, regional and national immunisation co-ordinators.
II. Improving the infrastructure for the provision of immunisation.
III. Improving the quality of immunisation service delivery, which includes ensuring culturally appropriate services.
IV. Developing information systems and information resources.

The Public Health Commission was disestablished and its tasks were taken over by the MoH in July 1995.

2.5.2 National immunisation strategy 1995

The new national immunisation strategy was launched on World Health Day 1995 by the then Minister of Health, the Honourable Jenny Shipley. The new national targets were (50):

I. To increase the proportion of NZ children with complete early childhood immunisation by the time they are two years old, to 85% by the year 1997, and to 95 percent or more by the year 2000.
II. To increase immunisation coverage of Māori to match the non-Māori rate by 1997.
III. To increase immunisation coverage in areas or populations with low coverage to be within 10 percent of the overall population coverage by 1997.

The strategy for achieving these targets included a range of health sector and non-health sector approaches. The three main ones within the health sector were to improve the quality of immunisation service delivery, the effective provision of immunisation, and monitoring and surveillance of immunisation. The non-health sector approaches included ensuring that parents and caregivers carry out their responsibilities for children's immunisation, and reducing the incidence of VPDs in schools and early childhood centres.

As part of this national strategy a new immunisation schedule with fewer visits was introduced in 1996 (51). The major components to this strategy were:

- For the introduction of an immunisation certificate. All children born since 1995 were to be required to present a certificate detailing which immunisations had been completed or declined when they started at all early childhood centres and primary schools.
- To develop standards to improve quality. Roles and responsibilities for caregivers and vaccinators, and new standards for vaccinators and organisations offering vaccination services were developed and added in Appendix One of the 1996 Immunisation Handbook (35).
- For a nationally driven and purchased model for immunisation co-ordination: nationally, regionally, and locally.
- To improve the monitoring and surveillance of immunisation, with the intent to have nationally comprehensive information before June 1999, including immunisation timeliness data by gender, ethnicity, and locality.

2.5.2.1 Progress since the national immunisation strategy 1995

In 1998, a single national HFA was formed from an amalgamation of the then-existing four RHAs. This new authority led to the recognition of the need for a nationally consistent system for funding immunisation services (35). A review of immunisation co-ordination following this in 1999 concluded that immunisation co-ordination, in line with the national immunisation strategy, needed to be contracted through a centralised, immunisation-focused, national organisation beneath which would operate regional and local services. Immunisation co-ordination was identified as needing to be population-based, allocated to specific geographical areas, accountable, and responsible for reporting on all children in the area of service delivery (52). Following this review, national and regional immunisation coordination was purchased nationally through IMAC at the University of Auckland and local coordination was purchased with a range of providers, including IMAC, local public health providers, and Independent Practitioner Associations (IPAs).

2.5.3 National Health Committee report 1999

The National Health Committee in 1999 was an independent statutory body that had terms of reference to advise the Minister of Health as to *whether the current and proposed public health, personal health and disability support services funded by the HFA are a fair and wise use of resources* (53). The committee examined and reported on current HFA strategies to deliver immunisation to what was described as ‘hard to reach’ children.

This report concluded that NZ had not achieved immunisation coverage levels sufficient to be protective for both individual children and for the community, and included a package of recommendations, part of which pertained to immunisation coverage measuring and monitoring. The recommendations included:

I. A goal of 90% coverage in all population groups by July 2003 as a performance expectation between the MoH and the HFA.
II. The development of robust information systems by providers, particularly those working with ‘hard to reach’ groups, to ensure mechanisms are in place to provide complete, accurate national immunisation coverage information.

III. The development of the claims-based dataset as an accessible source of immunisation event information.

Other recommendations encompassed more national consistency: primary care funding and performance measures and incentives consistent with population outcome focus; utilising claims-based datasets as an accessible source of immunisation history; enrolment with primary care and Well Child services by six weeks of age; comprehensive locality plans; expanded provider education and immunisation promotion; supporting the national and regional coordination; and improved mechanisms to ensure compliance with preschool and school regulations.

2.5.4 Strategy from 2001 to 2006

In November 2001 the responsibility and management for immunisation service delivery moved fully to the public health directorate of the Ministry and has remained there as a national responsibility sitting with the MoH.

A public discussion document called *An Integrated Approach to Infectious Disease: Priorities for Action 2002-2006* was published by the MoH in 2001 (54). This document was developed to define the key priorities and strategies for infectious disease, based on a *broad, multi sectorial view of infectious disease transmission and control.* In this document the control of VPDs in children was placed as the highest priority. The problems needing to be addressed were identified as:

- The need for a national register or some form of linked regional/local data to provide accurate coverage rates and as a mechanism to enable follow up of incompletely immunised children.
- More focus needed on services for the *hard-to-access and highly mobile groups*.
- More support needed for a co-ordinated national strategy that includes providing accurate information to help parents with informed consent.
- Poor monitoring of adverse events following immunisation (AEFI).

*2.5.4.1 Strategies recommended in this docume*nt are listed below (from page 10) (54)

I. Establish and maintain a comprehensive online surveillance system, which integrates data on local, regional, and national progress on Immunisation. This needs to be able to provide accurate data to providers across NZ on a child’s immunisation status.
II. Enhance surveillance for VPD in the community, including laboratory notification and sero-surveillance.
III. Continue to improve access to immunisation services by:
    - Increasing the range of service provision (appropriate language and ethnicity of providers, development of specific community-based services to meet Māori and Pacific children’s needs, increasing the flexibility of existing services, a wider range of vaccinators, increased sites and hours of access, opportunistic immunisation (for example, after-hours clinics), and ensuring integration of immunisation and Well Child services so both activities are undertaken by the same provider).

    - Implementing policies to ensure that providers are motivated to immunise hard-to-contact groups and to provide information (this includes ensuring equitable and adequate resourcing and support for immunisation co-ordination and vaccinator training and support services).

IV. Remove immunisation disparities between socioeconomic and ethnic groups, by supporting health promotion education and care from Māori and Pacific providers and by those services working with disadvantaged groups.
V. Ensure that appropriate information is available to address providers' and parents' needs for knowledge about immunisation, through a co-ordinated, consistent communication strategy at national, regional, and local levels.
VI. Establish a policy framework and process for the assessment of new and existing vaccines (such as varicella), including cost-benefit analysis and enhanced surveillance of those diseases.
VII. Evaluate meningococcal B vaccine for introduction to the schedule.
VIII. Aim for the elimination of measles transmission by 2005.
IX. Undertaking planning to improve preparedness for VPD outbreaks (health workforce development, enhanced surveillance, pandemic planning etc).
X. Audit and evaluate service/providers for effectiveness in improving coverage.

2.5.4.2 Strategic direction for the National Immunisation Programme 2003-2006

Following the publication of the document on taking an integrated approach to infectious disease (54), the MoH released a document listing its strategic directions for the NIP for 2003 – 2006 (55). The overall goal was described as *to improve the health of all New Zealanders by controlling or eliminating vaccine-preventable diseases*. There was an objective *to ensure the delivery of safe and effective vaccination programmes to all children and their families in NZ*. There were two immunisation coverage targets:

- Ninety five percent of children in all ethnic groups are fully vaccinated at age two years by 2005. (Full vaccination defined as having received all antigens on the national schedule, as appropriate for their age).
- Seventy five percent or more of the defined high-risk adult population is vaccinated annually against influenza.

The implementation priorities were:

I. To implement an NIR as a basis for collection of Well Child information over time and a supporting tool for vaccinators, the DHBs and the NIP.
II. To introduce a meningococcal B vaccine in 2004-2005.
III. To improve access to immunisation services in primary care and outreach settings, to reduce inequalities in immunisation coverage, particularly for Māori and Pacific peoples.
IV. To develop an effective communication and promotion strategy for immunisation.

Figure 2.13 is a copy of the diagram from Appendix Two page 20 Immunisation in New Zealand Strategic Directions 2003-2006(55) which illustrates the implementation priorities.

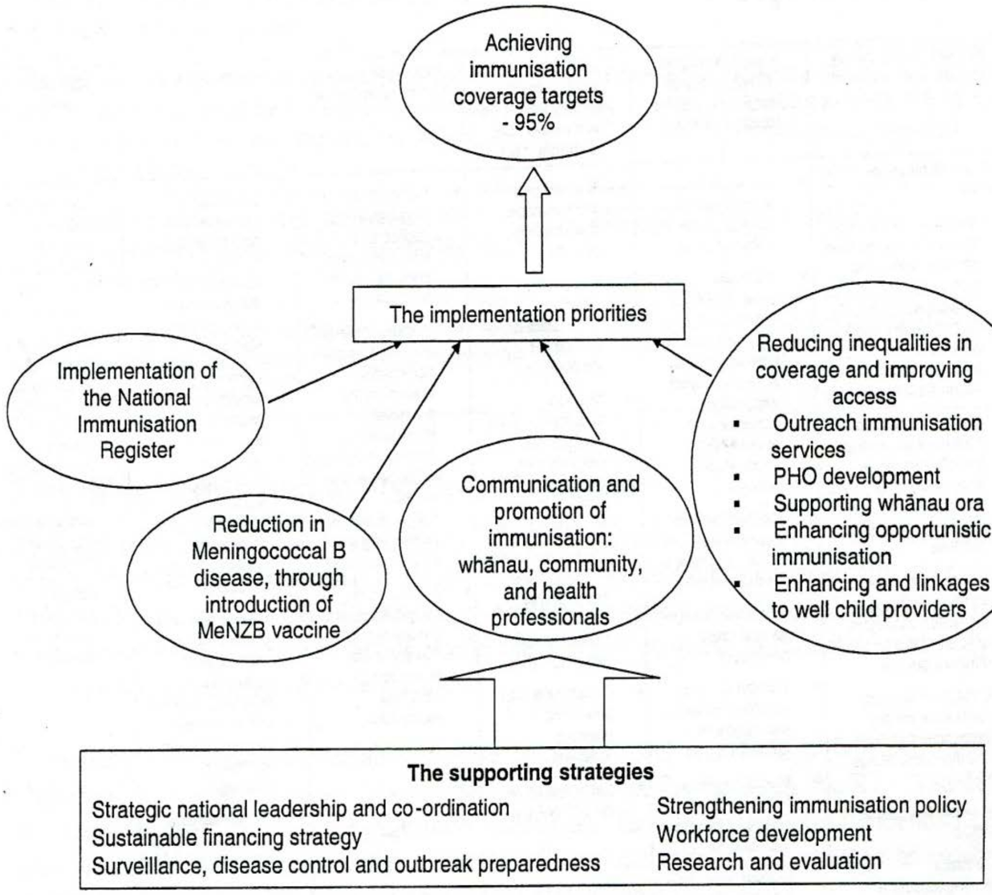
Achieving immunisation coverage targets - 95%
The implementation priorities
Implementation of the National Immunisation Register
Reduction in Meningococcal B disease, through introduction of MeNZB vaccine
Communication and promotion of immunisation: whānau, community, and health professionals
Reducing inequalities in coverage and improving access
▪ Outreach immunisation services
▪ PHO development
▪ Supporting whānau ora
▪ Enhancing opportunistic immunisation
▪ Enhancing and linkages to well child providers
The supporting strategies
Strategic national leadership and co-ordination
Sustainable financing strategy
Surveillance, disease control and outbreak preparedness
Strengthening immunisation policy
Workforce development
Research and evaluation

Figure 2.13: "How Do we get there? Addressing Priority Areas and Strategic Directions" from Appendix Two Immunisation in New Zealand: Strategic Directions 2003-2006

2.5.5 Progress from 2005

2.5.5.1 The introduction of the National Immunisation Register (NIR)

The NIR was introduced as part of the rollout of the meningococcal B vaccination campaign to control an epidemic of a strain-specific meningococcal B disease. The NIR was rolled out in NZ progressively from mid-2004.

The NIR contains all registered immunisation enrolments and events for all children born since 2005. Its purpose as defined by the MoH was *to provide data for monitoring immunisation coverage and the progress of immunisation campaigns such as Meningococcal B and HPV* (56). NIR collection started from August 2004, although it does also contain some earlier data from January 2002 populated from a child health database running in the Auckland and Midlands region called 'Kidslink'. Data from the Counties Manukau DHB started from January 2003 and there were variable other dates of starting from mid-2004 onwards from other DHBs.

The data coming into the NIR are sourced directly electronically from Practice Management Systems (PMS) from the general practice and from outreach service providers and from the schools-based vaccination system used with public health services for school-based vaccination. The NIR is populated with registrations from birth by

Lead Maternity Caregivers (LMCs). All children are entered on the register at birth to establish a full denominator, but there is parent/caregiver choice to decline vaccination.

There was no ‘backfilling’, so this register only contains universal data on all children born since 1995. Vaccination events and enrolments are updated every week.

2.5.5.2 The national health targets 2007-2008

In August 2007, the then Minister of Health, the Honourable Peter Hodgson, announced a set of ten measures to be the main focus on *how to ensure the health system is contributing to maintaining and improving the health of the NZ community* (57). The ten measures were called ‘health targets’ and described as a level of performance that aimed to achieve against a specific ‘indicator’ within a health area over a three – five year period (57).

Targets were seen as achievable, within a timeframe. Targets were to be incorporated into all the key planning and accountability documents, such as the DHB district annual plans and progress against targets to be publically reported quarterly. The first target was to improve immunisation coverage and there were two target indicators:

- Ninety-five percent of two-year-olds fully immunised.
- With at least a 4 to 6 percent point increase on 2005 national coverage survey baselines.

Current government funded services that support childhood immunisation were listed as:

- Immunisation given in general practice in primary care services.
- Outreach immunisation services (OISs) through other providers, including Māori or Pacific health providers, that are funded to find children overdue for the immunisation events and either immunise or refer to primary care services.
- Immunisation facilitators who provide information to health professionals and the general public.
- The IMAC that provides information and education to health care professionals and the public.
- Well Child health promotion services that promote immunisation.

2.5.5.3 Parliamentary select committee enquiry 2010

In response to concerns that NZ was failing to reach its national targets of 95% fully immunised by the age of 2 years, a parliamentary select committee enquiry was instigated. Submissions were called for in late 2009-early 2010. The results of this, with thirty recommendations and the government’s responses, were announced in 2011(58). See Table 2.9. The government supported the report and emphasised that it generally reflected current priorities within the MoH work programme.

Table 2.9: Recommendations and government responses

Number	Recommendation and Government response
1	For the MoH to publish an annual review of immunisation showing changes over time in coverage, disease rates and adverse events. • This was supported by the government.
2	For the MoH to introduce targets for timely immunisation in infancy and for older age groups. • The government, via the MoH, supported this, once the current target focus had been achieved of 95% fully immunised by two years of age.
3	For the MoH to get the current basic immunisation systems in order within the next 12 months. • The MoH's response was its intention to focus on improved integration between health services, education, and social services; continue to encourage leadership within DHBs; establish better coordination of services between maternity, Well Child and immunisation providers and improve accessibility and functioning of the NIR; simplify funding and contracting of local immunisation services; and review immunisation related health education resources in 2011/12.
4	For the government to "implement Dr Turner's 'Six Star' plan where there is a clear evidence base for doing so within the resources available" This Six Star plan was (59): Enhance business as usual Contractual legislative changes Improving responsibilities/support for primary care Improving responsibility/support for parents/caregivers Improving communications Improving safety surveillance • The government requested the MoH to consider this advice and report back to the Minister of Health. The MoH supported the majority of this plan, although it had some concerns that the IT systems and communications campaigns may be too costly.
5	For the government to review and implement the advice about hard-to-reach children and Māori where completed immunisation rates are often low.
6	For the government to continue its efforts unrelentingly to achieve on-target immunisation.
7	For the government to ensure that DHBs strengthen the PHO's performance programme and align it with the NIR data. • This was already underway.
8	That the government require DHBs to focus on providing good access to the NIR data and encouraging effective communication between the various organisations that provide immunisation services. • This was supported by the government within the appropriate privacy and consumer rights legislation.
9	That the MoH enable any health professional treating a child patient to access that child's immunisation status. • The government supported this with the same provisos as for recommendation eight.

Number	Government response to the recommendation
10	For the MoH to continue to improve the functionality of the NIR. • The MoH response was that they were undertaking a review of the policies and design of the NIR for 2011/2012.
11	For the MoH to support and maintain immunisation steering groups in all DHBs and that they coordinate on a regional and national basis.
12	That the government direct the MoH to explore providing incentives to immunisation providers and parents. • The government supported the exploration of options in this area.
13	That the MoH hold DHBs responsible for immunising the populations in their areas. This was supported by the government. • The MoH response was a planned focus on aligning contracts and fundings to match responsibilities.
14	That the MoH moves its funding of local immunisation-related functions to DHBs so that accountability and funding are aligned. • The MoH response was to take a planned move in this direction.
15	That the MoH require DHBs to enrol all new-borns with primary care and Well Child providers before they leave hospital and, at that time, immunisation should be explained and promoted. • This was supported by the government and the Ministry planned to take a range of further steps to achieve this.
16	That the MoH encourage DHBs to work with other social and community services to provide immunisation services. • This was supported by the government and further work is to be undertaken with the Ministries of Health and Social Development.
17	That DHBs be required to ensure immunisation services are available from a wide range of providers at times and in locations that suit the parents/caregivers. • The government supported this and the MoH pledged to explore further options.
18	That the government strengthen the requirements on parents to present immunisation information when their children enrol at early childhood centres or schools. • The Ministries of Health and Education pledged to explore this option further.
19	That the MoH tailors its communication about immunisation to audiences rather than to institutions. • This was supported by the government and the MoH had already commissioned research on this area.
20	That the MoH ensures it publishes up-to-date, readily accessible evidence-base data on the positive and adverse effects of immunisation for a robust evidence base for informed consent. • This was supported by the government and the MoH.
21	That the Ministers of Health, Social Development, and Employment continue to advocate for children to complete immunisation schedules. • This was supported by all.
22	That each DHB nominate a clinical leader to champion immunisation. • This was supported by the government and is to be encouraged via the MoH approaches to DHBs.

Number	Government response to the recommendation
23	That the MoH implement a national media or social media campaign to promote immunisation positively within the resources available. • The MoH undertook a targeted campaign in early 2001 and intends to continue campaigns focusing around international immunisation week.
24	That the MoH develop more readily available, evidence-based electronic resources for parents who research immunisation using the internet. • The Ministry response was to identify the existing sources currently available, the developing services and the communications campaigns.
25	That the MoH and DHBs ensure that up-to-date evidence-based immunisation information is included in the training of all professionals who care for mothers and babies. • This was supported by the government and MoH.
26	That the MoH strengthen the legal and contractual requirements of health professionals involved in maternity care to provide scientifically-credible immunisation information, in context including antenatal classes.
27	That the MoH builds websites about immunisation with content written by, and designed for, antenatal educators, lead maternity carers and Well Child providers. • This was supported by the government and recommended for the MoH to consult further with the health sector of the most effective approaches.
28	That the MoH review all the resources containing immunisation information aimed at parents to ensure that they are targeted to all the various audience segments, user tested, easily accessed and up-to-date. • This was supported by the government and the MoH, which reported it was redeveloping the current health education resource guidelines to inform a review of immunisation resources.
29	That the government fund free antenatal classes for all first-time parents, and ensure that the immunisation information is scientifically credible. • The government acknowledged that further work was needed in this area.
30	That the MoH review the monitoring of the adverse event system to make public reporting easier and more responsive to public needs. • The MoH advised that this would require more investment in IT and staffing, but will undertake further consideration of this area.

2.5.5.4 Revising targets: The 8 month target

While 95% fully immunised was not completely achieved, by the later part of 2012 91% were fully immunised, with almost complete closing of the traditional equity gaps for Māori, Pacific children and those from lower socioeconomic backgrounds. In recognition of the need to particularly focus on timeliness of delivery, in November 2012 the Minister of Health, the Honourable Tony Ryall, announced a shift in the immunisation target to focus more on timeliness. *Our goal is 95 per cent of babies fully immunised by the time they're eight months old, by December 2014, and that coverage rates be maintained until at least 2017* (60).

Table 2.10: National strategy for improving childhood immunisation coverage: 2001 to 2012

Summarising Policy 1991 – 2012	Targets	Recommendations	Actions
1993 Public Health Commission Report	Fully immunised by 2 years of age: - 80% by 1995 ≥90% by 2000	Develop a national immunisation strategy	Formation of an Expert Working Group to develop national strategy
1995 National Immunisation Strategy	Fully immunised by 2 years of age: 85% by 1997 ≥95% by 2000 Māori rates to match non-Māori Reduce equity to within 10% of overall population	Improve quality of services Improve provision of services Improve monitoring and surveillance Ensure parental responsibilities	Development of a national strategy
1999 National Health Committee Report	Fully immunised by 2 years of age 90% fully immunised by July 2003 In all population groups	Development of robust information systems for accurate national immunisation coverage information	
2001 Priorities for Action report		A more co-ordinated national approach Development of an NIR	
2003 NIP Strategic Directions	Fully immunised by 2 years of age 95% by 2005	Implement an NIR Improve access to reduce inequalities Develop a communication and promotion strategy	Development of a national strategy
2005			Development of the NIR
2007 National Health Targets	Fully immunised by 2 years of age 95% At least 4-6% point increase on 2005 coverage		Embedding accountability and public reporting
2010 Parliamentary Select Committee Enquiry		30 recommendations	
2012 revised National Health Targets	Fully immunised at 8 months of age 95%		Embedding accountability and public reporting

2.6 Immunisation coverage and timeliness, summarising trends over time: 1991 – 2012

Since the first national coverage survey in 1991/92, there were a range of strategies devised and targets aimed at improving immunisation coverage. Refer Table 2.10.

Below is a summary of the progress in immunisation coverage and timeliness of delivery over this time.

2.6.1 Progress as measured by the three coverage surveys

Data from the two national surveys in 1991-1992 and 2005 and the North Health coverage survey from 1996 can be validly compared, because these three surveys used the same WHO-recommended methodology. As can be seen in Table 2.11 from 1991-1992 to 2005, there was a noticeable improvement in immunisation coverage from 1991 through to 2005, showing overall a greater than 17% points rise for fully immunised at the age of two years, and significantly higher increases in reported coverage for Māori with a 27% point increase and Pacific children with a 35% increase. This showed that inequalities, as measured by ethnic gaps, decreased between the 1991-1992 survey and 2005 in both absolute terms and relative terms. Despite these gains, coverage rates remained well below the expressed national target of 95% coverage, with Māori matching non-Māori coverage levels, and increased coverage in areas or populations with low coverage to within 10% of the overall population coverage by 2005 (55).

Table 2.11: Comparison of immunisation coverage results (fully immunised at two years of age) from 1991/92, 1996 and 2005 coverage surveys (with 95% confidence intervals) and the National Childhood immunisation coverage survey 2005

Ethnicity	1991/92 National survey	1996 North Health survey	2005 National survey
All	<60%	63.1% (59.1-67.1)	77.4% (75.3-79.5)
European/other	Not available	72.3% (67.5-77.1)	80.1% (77.4-82.9)
Māori	42.0%	44.6% (35.5-53.7)	69.0% (63.7-74.3)
Pacific	45.0%	53.1% (43.7-62.5)	80.7% (73.7-87.6)
Asian	Not available	Not available	79.8% (71.4-88.2)

2.6.1.1 Population groups with risk factors contributing to a likelihood of lower immunisation coverage

Other measurements of equity gaps are more difficult to compare across the three surveys; in particular the measure of socio-economic hardship was not standardised until the NZ Deprivation Index was used in the 2005 survey. Based on parental/caregiver responses to the questionnaires in 1991-1992, the most common risk factors for reduced likelihood of being fully immunised were parent/caregiver receipt of a government benefit, Māori ethnicity, household mobility, and younger age of the parent/caregiver. The 2005 survey had a slightly longer but very similar list that included lower household income, NZ deprivation index, ethnicity, household mobility, younger parent/caregiver, sole parent, and parents with less high school education. A multivariate analysis concluded that the only significant variables were household mobility and Māori ethnicity of the child.

2.6.2 Progress as measured by combining different data sources

2.6.2.1 Coverage at two years of age

Figure 2.14 illustrates the trend in fully immunised by the age of two years. This figure is using two different data sources - the immunisation coverage surveys at 1991-1992, 1996-1997 and 2005, and the National immunisation coverage data from 2005. Overall the trend suggests there has been an improvement in coverage of over 37% over this era, with a 21% gain from 1991 through to 2005 and a 15% gain from 2005 to 2012. These are not comparable data sources, so the absolute changes in coverage need to be treated with caution.

The data from the immunisation benefits claims/capitation practices have not been included as it is difficult to gauge its accuracy. These data did suggest there was a drop in immunisation coverage from 1996 to 1998, which then appeared to improve again from 1999. However with the significant limitations in the quality of this data, no clear conclusions can be drawn.

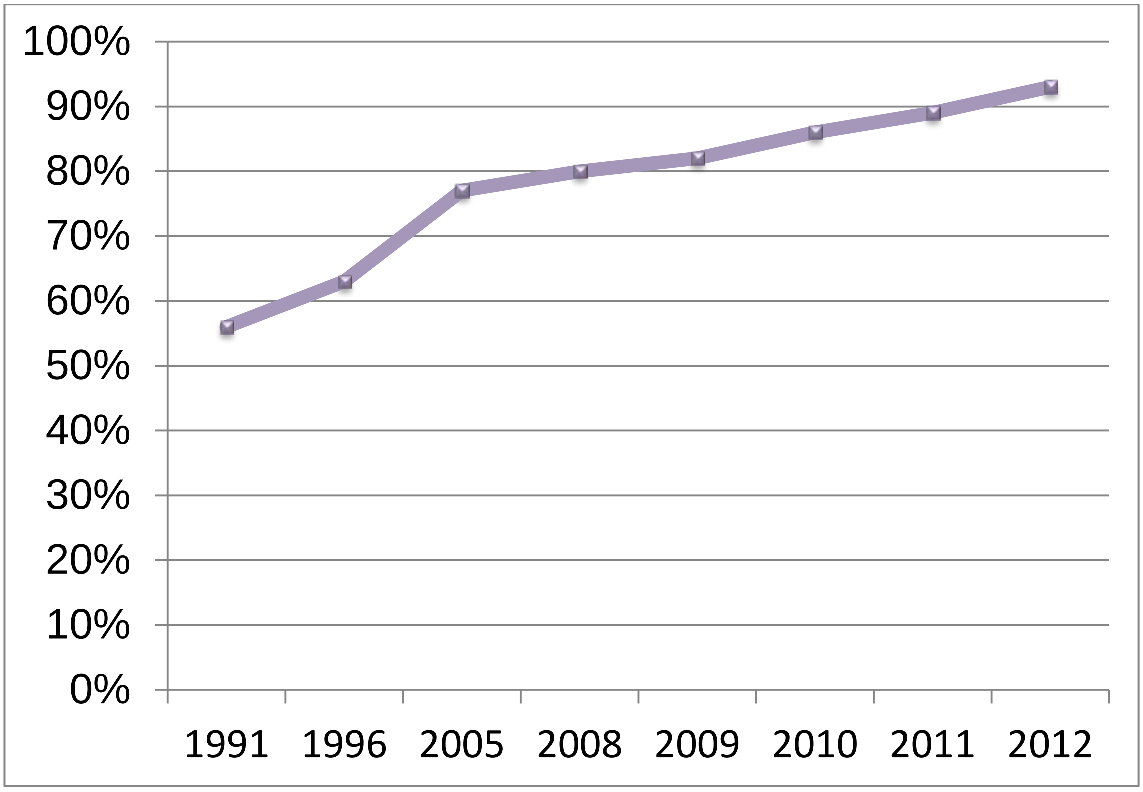

Figure 2.14: Immunisation coverage 1991 to 2012, fully immunised by two years of age using different coverage data sources

Figure 2.15 has used the two immunisation coverage surveys and the NIR data from 2005 and extrapolated for the years for which were there no available data. This provides a clearer picture of immunisation coverage changes over the full time period. National policy and targets have been added to the timeline. There appears to be a steady rise in coverage from 2001-2002 to 2012, with a particularly marked rise from 2005 to 2007. This coincided with the introduction of the new national targets, with DHB accountability and public feedback. However as this was the period the NIR was just coming into place, there is no assessment as to the accuracy of the early NIR data, so caution is required before assuming that this progress has been driven by the national targets.

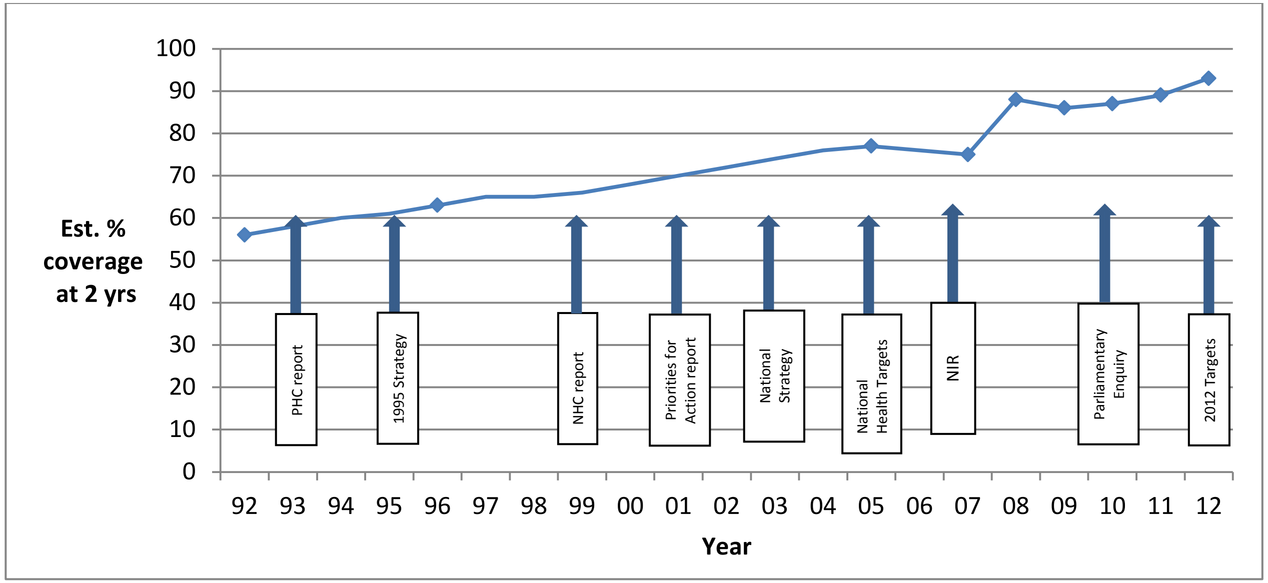

Figure 2.15: NZ immunisation coverage 1991 to 2012, fully immunised by two years of age using different coverage data sources and estimating other years

2.6.6.2 Timeliness

Estimates of changes in coverage for timeliness of delivery over this full period of time are difficult because different methodologies have been used.

The 1991-1992 coverage survey reported a difference in immunisation coverage at the time of interview (any age from two years and zero days to just under four years) of 5-10%. The 1996 North Health survey reported the difference to be 6% and the 2005 survey reported a difference of 4.2%. This suggests there was some improvement over this period in the timeliness by the age of two years.

To look at timeliness for earlier events, the third immunisation event due to be given at five months of age can be compared. The coverage surveys estimate full immunisation after the first three DTP events (i.e. a month after the third event) as 52% in 1991-1992, 86% in 1996 (North Health only) and 88.6% in 2005. The benefit/capitation data estimate full immunisation after the first three doses of DTP at 87% in 1997, 76% in 1998 and 85% in 1999. NIR data reports fully immunised at six months of age, which is similar but not identical to a measure of DTP3, reported as 64% in 2006 and rising to 74% in 2012.

Another useful comparable measure is timeliness in the second year of life using coverage rates for the MMR1 vaccination event. In 1991-1992, approximately 53% of children were reported as immunised within a month of the due date. In the North Health region in 1996, this figure was 80% and in 2005 it was 82%. The 2012 NIR data is not reported in the same format, but indicates 81% fully immunised by 18 months of age for all due antigens.

It is difficult to make assumptions from these data; however, it does suggest there were generally positive improvements in the timeliness of delivery from 1991-1992 to 2005. For the third DTP vaccination event, there was an improvement of 32% (52% - 84%) over this 15-year period. Using a different methodology of assessment, with the NIR data measuring all immunisation delivered by age six months, the baseline was initially lower, but steady improvement was observed from 2006 to 2012 with an improvement of ten percentage points fully immunised at six months of age (from 64% to 74%) in this seven year period.

It is noteworthy that the improvement in coverage appeared initially to be more at two years of age, which has levelled off in the past two years. However in the most recent years there has been more improvement in timeliness of delivery as measured by the coverage at six months of age. Refer Figure 2.16. The national target for two years of age was introduced in 2007, and changed to a timeliness measure at eight months of age in 2012. It is not clear how much the national target has driven the differential gains in coverage for the six month and the two year old age group. Figure 2.16 shows the differences in improvement at 6 months and two years of age based on NIR data from 2005.

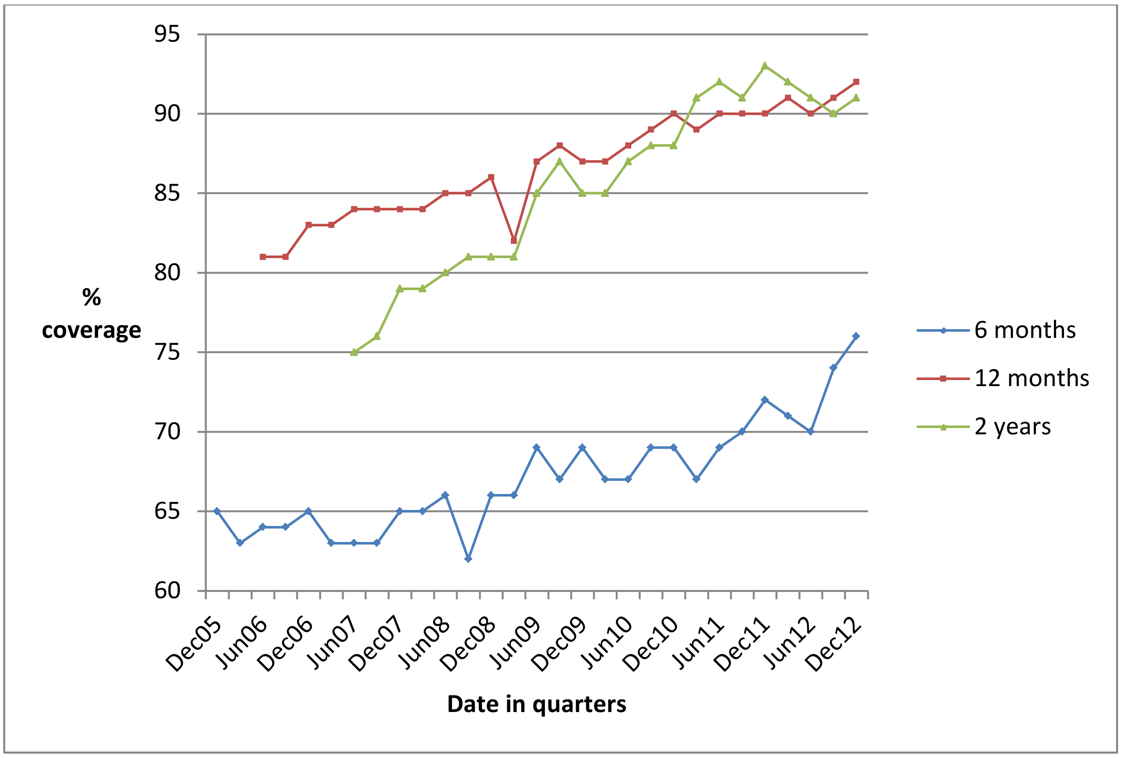

Figure 2.16: Coverage data based on NIR reports for six months and two years of age

2.6.3 Equity gaps in coverage

2.6.3.1 Ethnicity

Significant improvements in closing the traditional equity gap by ethnicity measures have been seen over this period since the 1991-1992 survey. The earliest coverage data at 1991-1992 did not officially record coverage by ethnicity. However it stated that children of caregivers who reported to be Māori were 70% less likely to be immunised. If this 70% is applied to the total coverage rate of 56%, an approximation can be made of a rate for Māori children of around 39.3%. There was no official comment on rates for Pacific children. For the 1996 North Health survey, 45% of Māori children were reported as fully immunised at the age of two years, compared with 72% for children of NZ European identity, giving a gap of 27% lower for Māori, i.e. these children are nearly two thirds less likely to be immunised. Pacific children had better coverage with rates at 53%, which was a gap of 19 percentage points behind NZ European children. By the 2005 coverage survey, Māori coverage rates at two years of age had improved to 69% compared to 77% of NZ European, giving a smaller gap of 8% and Pacific children had higher recorded rates than NZ European at 80%. The most recent coverage data from the NIR for the last quarter of 2012 data give a coverage rate of 91% for NZ European, 90% for Maori and 93% for Pacific, showing an almost complete elimination of the ethnic gaps at the age of two years. Refer Figure 2.17.

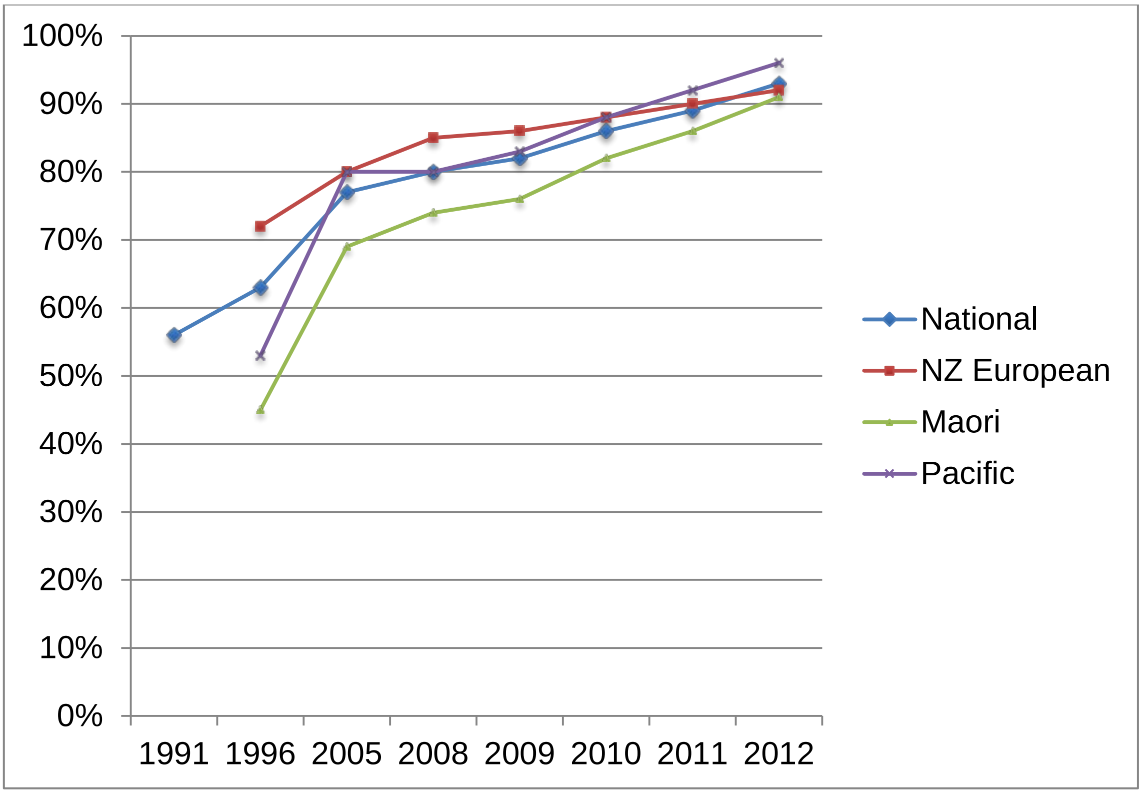

Figure 2.17: Immunisation coverage 1991-2012, fully immunised by two years of age using different coverage data sources

2.6.3.2 Socioeconomic status

The other traditional equity gap is for children living in households with economic deprivation to have lower immunisation coverage than those with less economic deprivation in their environment. This was reported in the 1991-1992 survey that noted that children from households where the principal income was from a government benefit were two-thirds less likely to be immunised than those whose caregivers were in employment. Using government benefits as a proxy for poverty, I estimate that, at two years of age approximately 37% of these children would have been fully immunised.

From the 2005 survey, children of households in which the principal income came from a benefit were half as likely to be immunised (OR 0.53). This would give an estimated coverage at the age of two years of 41%. Children living in a household defined as lower income (≤ $40,000) were 60% less likely to be fully immunised at age two years (OR 0.60) which would give an estimated coverage of 47.5%. When measuring by quintile using the NZ 2001 Deprivation Index, children living in quintile four were 57% as likely to be immunised compared with those in the highest quintile group. However, there was no significant relationship for decile five. There has been significant progress since the coverage survey results. The NIR results for the last quarter of 2012 show a complete closure of this traditional equity gap with full immunisation at the age of two years at 92% for children from NZ deprivation quintiles 1-2, 90% for those from deprivation 5-6 quintile, and 91% for those from deprivation quintiles 9-10. This data is summarised in Figure 2.8.

2.6.6.3 Geography

The 1991-1992 survey only broke down geography by the four RHAs. There was a non-significant trend for coverage rates to be higher in the South region compared to further North, with a 2% difference from the North

RHA to the South RHA. The 1996 survey was only in the Northern RHA but showed a non-significant trend for there to be higher coverage in the West Auckland region of around 11% over the lowest performing region of Northland. The 2005 national survey showed a similar north to south trend with a non-significant increase of around 6.5% coverage seen from the North RHA to the South RHA.

Data from the NIR since 2005 has shown significant variability in coverage between DHBs, and while there is a general trend for higher coverage in the more Southern DHBs, this is not always consistent. Furthermore, while the general national trend is for the highest deprivation quintile to have the lowest immunisation coverage, there is considerable variance between DHBs, as seen in Figure 2.10 and Figure 2.11.

2.7 Conclusions on immunisation coverage

Immunisation coverage is important to record and monitor to help gauge the effectiveness of an NIP. In NZ, prior to 1991, there were no standard national-reported measurements of childhood immunisation coverage. From this time, the NZ health authorities became aware of the need to measure and monitor coverage, to develop targets, and to review progress and develop strategies in response.

NZ had very poor immunisation coverage when first measured in 1991/92, with full immunisation at the age of two years achieved in less than 60% of all children and with equity gaps seen for Māori children, children from parents more likely to be living in poverty, and children from more mobile households. Furthermore, there were low immunisation rates for timeliness of delivery with the same equity gaps patterns, particularly for Māori. Since 1991-1992 further coverage reports also highlighted equity gaps in coverage milestone and timeliness of delivery for Māori children, Pacific children, children of immigrant families, and children in households more in poverty, as well as geographical variations with a tendency to higher coverage in the more southern regions of the country. There were also trends towards lower coverage for households where the parent/caregiver is of younger age, sole parents and parents with lower education status, and for immunisation events due at the older ages.

There have been a range of reports, strategies, policies, measures, and targets put into place to improve immunisation coverage and excellent progress has been made since the early 1990s. By the end of 2012, immunisation coverage at the milestone age of two years was stable around 91% with significant narrowing of equity gaps for ethnicity and socioeconomic status (SES). Small equity gaps still remain, particularly for Māori children and geographical variation between DHBs.

When reviewing the gains in immunisation coverage alongside the national policies and targets it appears that overall national policy has likely contributed to improved immunisation coverage and reduced equity gaps. There is a suggestion that the targets set in 2007 particularly drove improvements in coverage for the milestone age of two years.

When measuring timeliness of delivery, progress over this time period has also been evident. Improvements in timeliness of delivery have been more evident in the latter two years of this period and the new target for 2012 appears to have driven improvement in timeliness of delivery, as seen at measurements of coverage at six months and eight months of age.

The plateau of coverage at two years of age from 2011 has meant that the target of 95% has not been achieved. There are too many other variables to ascertain whether the moving of the national coverage target from the age of two years to eight months has affected this by shifting the focus of service delivery to the earlier immunisation events.

2.8 Summary of Chapter 2

In this chapter I discussed immunisation coverage, the purpose of measuring its extent, and the NZ measurements of coverage for its national childhood immunisation programme from 1991 to 2012. I outlined the major methodological ways coverage has been measured.

I then outlined the major reports and strategy from the NZ national health authorities over this period that responded to immunisation coverage measures. Following that, I showed the trends over this time in improvement in coverage and reductions in equity gaps and mapped these alongside the national health initiatives.

CHAPTER 3 INTERNATIONAL LITERATURE REVIEW OF IMMUNISATION COVERAGE

3.1 Outline of Chapter 3

The aim of this chapter is to review the international literature in order to identify the range of issues that affect immunisation coverage. The purpose of this review is to identify factors that are positively and negatively identified with improvements in immunisation coverage in settings outside of NZ. These can then be compared and contrasted with the findings from my own NZ studies that will be reviewed in the following chapters.

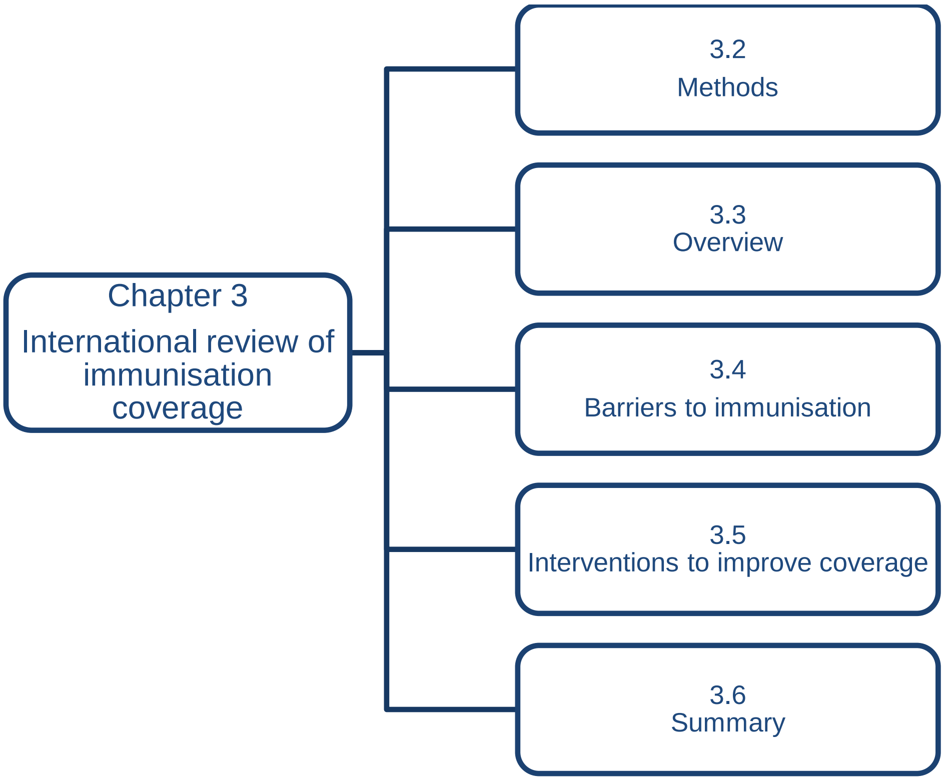
Chapter 3
International review of immunisation coverage
3.2
Methods
3.3
Overview
3.4
Barriers to immunisation
3.5
Interventions to improve coverage
3.6
Summary

Figure 3.1: International literature review of immunisation coverage

3.2 Introduction to the review

3.2.1 Background

Childhood immunisation programmes are internationally well recognised as some of the most cost-effective activities in healthcare (2). Immunisation has eliminated smallpox from the world since 1979, is close to eliminating polio, and has delivered huge reductions in rates of other significant childhood diseases such as measles, pertussis, diphtheria, hepatitis B, and haemophilus influenza type b. The gains stand to be even higher if universal high coverage is achieved with all these vaccines; and even further gains with the introduction of significant new vaccines, such as the conjugates pneumococcal and meningococcal, rotavirus, and varicella vaccines.

Despite the overall success of immunisation programmes, almost 11 million children under five years of age die each year of VPDs. Internationally, immunisation coverage has increased to over 70% for the third dose of DTP since the early 1990s. However, there were, and remain, dramatic inequalities between and within regions. One of the starkest is in Sub-Saharan Africa where in many places immunisation rates have never reached higher than 55% for the third DTP dose (61). The world has a long way to go to increase overall coverage and reduce the inequities before the full gains of immunisation are apparent for all children.

A review from 96 low and middle income countries acknowledged that childhood immunisation coverage levels have increased since the 1970s, but there remain significant inequities in coverage both between and within countries (62). Despite marked heterogeneity, across this survey there was an average of just under 10% of children unvaccinated at 12 – 59 months.

3.2.2 Rationale

The purpose of this chapter is to systematically review the international evidence regarding barriers to obtaining and maintaining high immunisation coverage in NIPs. This can then add context and understanding to the NZ research.

3.2.3 Objectives

To review and commentate on all published literature internationally for studies that affect immunisation coverage in children two years of age or under across two general areas:

- Studies that identify reasons for low or high immunisation coverage; and
- Interventions that either positively or negatively affect immunisation coverage.

3.3 Methods

3.3.1 Original review 2007

The first part of this review was undertaken in 2007 and presented in my Masters in Public Health Thesis titled *Missed Opportunities to Immunise at the General Practice Level* (63). This approach taken for this original review is outlined in this thesis. From this review I searched all papers and identified all articles that were relevant to immunisation coverage in young children and intervention studies that affected the immunisation coverage of childhood vaccination programmes.

3.3.2 Main review

Adding to this original literature collection, a more current review was then undertaken on published reviews and articles from 2008 to 2013 that focused around reasons for low immunisation coverage in national programmes and interventions that improve immunisation coverage. This review used the PRISMA guide 2009 criteria for a systematic review.

The participants in the review cover age ranges from the first immunisation event delivered from birth upwards to the completion of the primary infant series in the first year of life and the vaccinations given in the second year of life. Schedules are variable from country to country, but all take the form of a primary series of three: a single vaccination event for measles or MMR in the first or second year of life and several booster doses in the second year of life. Interventions undertaken vary from RCTs to observational studies.

Outcome measures are usually changes in immunisation coverage as measured by absolute or relative changes in the percentage of children in a population vaccinated and measured at different time points. Comparison groups were either matched with controlled trials or before-after comparisons. Study designs were all observational and systematic reviews for the review of barriers to immunisation. For the intervention studies, there were a mixture of observational and control studies with pre- and post-test designs, longitudinal intervention trials, randomised control trials, and systematic reviews.

3.3.2.1 Eligibility criteria

The inclusion criteria were all studies, qualitative and quantitative, related to immunisation coverage and interventions designed to affect immunisation coverage for infant and childhood immunisation programmes. Excluded were all articles prior to 2008, all non-English articles, those based on non-human subjects, and those designed around only older children and/or adults. The review was restricted to all articles from the beginning of 2008 to August 2013.

3.3.2.2 Information sources

The databases Medline, Cochrane Database of Systematic Review, Scopus, and Embase were utilised.

3.3.2.3 Search strategy

This review was undertaken from the beginning of 2008 – current (August 2013) and all searches were limited to this time period. The first search was undertaken in Medline using the MeSH terms i*mmunisation*, *coverage*, *vaccination*, and *child*, including all subgroups. It was then limited to articles on humans only, in English only, and based on infants (which is defined as from. birth to 23 months). The search was then repeated in the Cochrane Database of Systematic Review using the search term *immunisation coverage* and limited to full systematic reviews excluding protocols. The search was then further repeated in Scopus using the search term *immunisation coverage* and limited to medicine, human-only, articles-only, vaccination, child, journals and in English. Finally the search was repeated in Embase using the search term *immunization coverage* and limited to human and articles only in English.

Refer to Figure 3.2 for the summary of the literature review process and outcomes.

3.3.2.4 Study selection

Articles were identified through the search methods listed above, titles were screened, and duplicates were removed. Abstracts from all articles that fell within the search terms were read for eligibility and those not relevant to the objectives were removed. For the remainder, the full papers were obtained and reviewed; those deemed not relevant to the objectives were excluded. Upon reading the papers, further articles were identified from the reference lists and obtained if they appeared relevant to the objectives.

The articles were divided into two groups: those pertinent to factors affecting immunisation coverage and those pertinent to interventions designed to improve immunisation coverage. All papers were initially divided into these two subheadings. Analysis was undertaken under the two areas. Under each of these subheadings, papers were further grouped into broad themes and tabulated based on each of the main themes. A narrative analysis was undertaken under each theme heading and results were synthesised. Finally, conclusions were drawn from each of the themes and synthesised further into combined summaries and conclusions for each subheading.

3.4 Results

3.4.1 Number of studies screened

From the historic review, 29 studies were identified that were considered to be still of value to this review. Adding to these 29 articles, the Medline search accessed and screened 217 articles; of these 63 were considered relevant. The Cochrane database identified 12 articles of which 5 were identified as relevant to this review. Six of the others discarded were protocols only. The Scopus search identified 72 papers, of which 10 were relevant and not already identified from the first two searches. The Embase search identified 61 relevant papers, of which 4 were not already identified from the first three searches. The CINAHL search identified 15 articles as relevant. Of these, all had been identified from the previous three searches. One further article of relevance was identified via reviewing the reference lists in the relevant papers. Refer to the flow chart Figure 3.2 below.

The process with each database is listed below:

I. Medline search terms and strategy

MeSH term: *immunisation coverage* including all sub groups: Number = 1434
Limit to: Humans, English, year 2008 – Current, all infants (birth to 23 months): Number = 217
Duplicates = 4. Number with deleted duplicates = 213

II. Cochrane Database of Systematic Review search terms and strategy

Search term: *immunisation coverage*
Limit to full systematic reviews, 2008 – current: Number =12
Exclude adults, older children, disease, specific, vaccine devices, vaccine safety, protocols: Number = 5

III. Scopus search terms and strategy

Search term: *Immunisation coverage*
Limit to Published 2008 – present, medicine, human, article, vaccination, child, journals, English: Number = 1900
Additional limits - human, article, vaccination, child, English: Number = 310
Exclude influenza: Number = 72
Delete 50 duplications from previous searches: Number = 22

IV. Embase search terms and strategy

Search term: *Immunization coverage*

Limit to published 2008 – current, human, English: Number = 2260

Additional limits – infants: Number = 61

Delete 57duplications from previous searches: Number = 4

V. CINAHL Plus search terms and strategy

Subject term: (Bollean/phrase) *immunization* AND *immunization coverage*: Number = 535

Limit to English language, Peer Reviewed, published date 2008 – 2012: Number = 38

Additional limits - published date 2008 – 2012: Number = 15

Delete duplicates from previous searches: Number = 0

Final Library: Number = 29 historic and 87 new articles

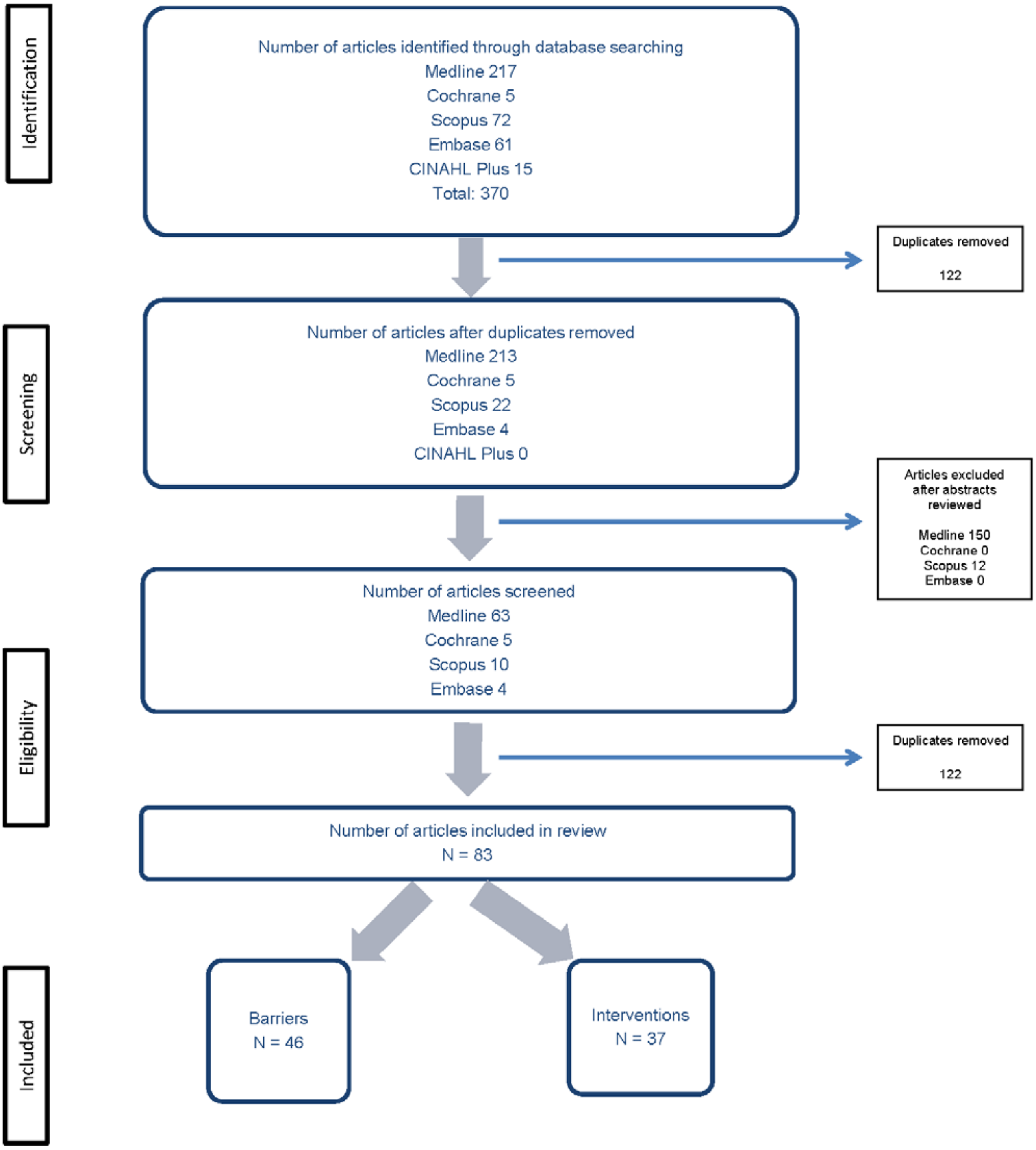

Figure 3.2: Flowchart of literature review undertaken 2008 to 2013

3.4.2 Categorisation of the identified articles

The 29 historic and the 83 identified papers were all reviewed. Two separate categories were identified and the articles divided between the two categories. See Figure 3.2 above:

- Barriers to obtaining high immunisation coverage.
- Interventions to improve the uptake of immunisation services.

3.4.3 Results and Discussion: Barriers to obtaining high immunisation coverage

There were 46 articles identified that addressed the topic of barriers to obtaining high immunisation coverage. Of all the articles, 32 were identified as adding new information in the area. These articles were further divided by grouping into major themes that form associations with immunisation coverage. These themes were originally based on the US National Vaccination Advisory Committee (NVAC) summary literature review in 1999 (4). This review concluded that there were three major significant barriers to obtaining high immunisation coverage:

- Those related to poverty.
- Family and child factors.
- Delivery systems and provider practices.

These themes were then expanded upon reading the articles into six themes: related to poverty; geography; minority ethnic, indigenous and migrant groups; child, family and community characteristics; health systems; and health providers and recommendations. Historic articles and commentary articles that did not add any new study material were not included in the themes, but were used in discussions where appropriate. Several articles were used under more than one theme. The references from the earlier review undertaken prior to 2008 were used in the discussion where appropriate but not included in the summary tables:

3.4.3.1 Poverty-related barriers to obtaining high immunisation coverage

3.4.3.1.1 Results

There were 23 articles identified in this category. Refer Table 3.1.

Table 3.1: International studies since 2007 on the association between poverty and immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Barata 2012 (64)	Brazil	Observational: Household cluster survey in 26 cities	17,295 children aged less than 18 months	To identify factors associated with incomplete coverage	77.2% fully immunised in higher SES areas, versus 81.2% in lower SES areas.	Lower coverage associated with residing in higher SES area and higher birth order
Bondy 2009 (65)	Philippines	Observational: Survey data analysis 2003	Nationally all children 12 – 23 months	To identify the risk factors for partial vaccination	69% overall fully vaccinated at time of survey	Associations with low coverage: maternal lower education, fewer antenatal visits
Bosch-Capblanch 2012 (66)	International – 96 countries	Observational: Retrospective analysis of multiple surveys	Children 12-59 months in low and middle income countries	To explore predictors of non-immunisation	Overall 9.9% all children non-immunised	Associations with poverty, parental education, caregiver TT status, family participation in health-seeking behaviour
Bosch-Capblanch 2009 (62)	International – 41 countries	Observational: Retrospective analysis of multiple surveys	Children 12-59 months in low and middle income countries	To measure accuracy and quality of immunisation information systems	Verification of immunisation coverage measure less than 80% for almost half of the countries	A WHO-validated tool is effective in identifying problems that affect quality of immunisation coverage data in all tiers of healthcare systems
Fadnes 2011 (67)	Uganda	Cluster-randomised trial Eastern Uganda	765 Children birth – 2 yrs	To describe vaccination coverage and timeliness	90% fully immunised for EPI vaccines except measles 80% coverage	Significant problems with timeliness of delivery, association with lower maternal education
Lauridsen 2011 (68)	India	Data analysis	Data from national family health surveys 2005-6, children born since 1 Jan 2000	To use a concentration index to quantify socioeconomic distribution of not fully immunised children	Child from poverty 59% higher risk of not being fully immunised, 85% higher risk with illiterate mother, 8% higher for rural mother, 35% higher for birth order 3 or more.	Most predictable SES inequalities arise from 4 socioeconomic predictors: poverty, maternal illiteracy, per-capita state domestic product and % illiteracy at the State level.
Naeem 2011 (69)	Pakistan	Cross-sectional survey	Parents of 548 children aged less than 1 yr, urban and rural area	To identify factors related to vaccine failure or missed events	Urban coverage 76.5%, rural 48.8%	Urban barriers lack of awareness, parents too busy. Rural barriers – access to facilities, misconceptions
Odusanya 2008 (70)	Nigeria	Observational: Cross-sectional survey, rural region	339 mothers of children 12-23 months	To assess determinants of vaccination coverage	Coverage 61.9%. 99% positive attitudes, 55% knowledgeable re VPDs,	Associations with high coverage: maternal knowledge, privately-funded facility

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Opwora 2011 (71)	Kenya	Observational: Questionnaire, parents and HCWs	397 caregivers of children <5 yrs leaving healthcare service, 45 key informants	To investigate barriers to accessing healthcare services	No immunisation coverage measure	Associations with barriers to access healthcare services: long waiting times, perceived poor services, incompetence and poor HCW attitudes
Owhino 2009 (72,73)	Kenya	Observational: Cross sectional descriptive survey, slums of large city	Parents of 712 children aged 12 – 23 months	To determine the factors influencing immunisation coverage	Access 95.6%, fully immunised 69.2%	Barriers to immunisation: maternal age, lack of record card, but not accessibility to services
Oladokun 2009 (73)	Nigeria	Cross-sectional survey,	418 female traders in urban region with children 12-23 months	To identify factors for children being at risk of low immunisation	Full immunisation 40.7%,	Low coverage overall for children of traders
Oladokun 2010 (73)	Nigeria	Observational: Cross-sectional survey	418 female traders with children 12 – 23 months	To assess the determinants of immunisation coverage	Full immunisation 40.7%	Major barriers to completion of immunisation: non-availability of vaccines, unaware of need for extra doses, inconvenient times, no maternal formal education, health beliefs
Phukan 2009 (74)	India	Survey in one region	Parents of infants less than 1 yr	To identify factors behind low immunisation coverage	Fully immunised 62.2%	Low coverage associated with parental lack of information, urban areas, low maternal education
Rahman 2010 (75)	Bangladesh	Observational: Analysis of survey data	Rural children up to 5 years of age, national survey	To identify factors associated with complete immunisation status	Overall 60% of all children fully immunised	Associations with poverty, distance from services, birth interval too close, parity, maternal age, mass media, child of female sex
Sahu 2010 (76)	India	Observational: National survey data analysis	Children nationally 12 – 23 months	To identify factors behind low immunisation coverage	Not reported	Low coverage associations with lower parental education, child birth order, no antenatal care, lack of healthcare facilities and less promotional, communication activities
Semali 2009 (77)	Tanzania	Observational: Combining 4 parental surveys in one region	Parents of 550 children 12-23 months	To identify factors associated with completion of immunisation coverage	87.7% immunised	Lower completion associated with lower maternal education, rural, poorly accessible roads, less than 3 under 5, poverty, female head of house

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Semali 2010 (78)	Tanzania	Observational: Combining household survey data	Representative households, all regions. Children 12-23 months, using 3 time points	To determine trends in disparity in access to preventative services, including immunisation	No disparity in completion of immunisation from 1990 – 1996, Increasing disparity to 2004 but no change in total coverage	Associations with increasing inequities with poverty. Strategies need to be focused on governance and healthcare systems
Sensarma 2012 (79)	India	Observational: Cross-sectional survey of caregivers	256 caregivers of children 12-23 months, where a parent was HIV positive	To identify proportion of children living with HIV positive caregivers with complete immunisation	73% fully immunised, matching non HIV households in same area	Associations with lower coverage: maternal less antenatal care, lower education levels, Hindu and Christian, certain castes and tribes
Sia 2009 (80)	Burkino Faso	Observational: Combining survey data and questionnaire, 2 time periods	805 and 1360 children 12-23 months in 48 rural districts	To identify individual and systemic factors associated with complete immunisation coverage	An increase in coverage from 25.9% in 1998 to 41.3% in 2003. 7.4% regional variance	District resources no effect. Education initial effect but declined over time. Barriers: poverty, healthcare, less utilisation of healthcare services. Continuing from antenatal care important
Sinno 2009 (81)	Lebanon	Observational: Random selection chart review	774 children and 154 parents enrolled in health insurance plan,	To describe predictors of compliance with the immunisation schedule	54.6% fully immunised by 4 yrs	Associations with lower coverage: older children, low maternal education, use of other health care facilities
Som 2010 (82)	India	Observational: Survey of households, one region	1,279 children 12-35 months	To identify inter-district variation in immunisation coverage and reasons	54% fully immunised, district ranges from 23.3% to 72.2%	Associations with lower coverage: poverty, rural, low maternal education
Van Malderen 2012 (83)	Kenya	Observational: Combining survey data, 3 time periods	Children under 5 years stratified by region, urban/ rural	To analyse socioeconomic inequalities in use of skilled birth attendance and measles vaccination uptake	Overall reduction in measles coverage explained 40% by wealth index, 28% by parental education, 9% by antenatal care, 33% by birth order, -19% by rural.	Barriers to higher measles vaccine coverage were primarily poverty driven and included parental education, birth order and urban residence
Wiysonge 2012 (84)	Sub-Saharan Africa	Observational: Combining survey data from 24 countries	27,094 children 12-23 months	To analyse factors affecting completion of childhood immunisation	21% variance due to country, 32% due to community level factors	Barriers to completion of immunisation: parents with no formal education, poor households, reduced maternal access to media, mothers with lower health seeking behaviour, communities with high illiteracy rates

3.4.3.1.2 Discussion

Consistent with the NZ coverage data as presented in Chapter 2, many studies historically have shown a strong link with poverty and under-immunisation (66).This was well demonstrated in a US random digit telephone survey to assess immunisation coverage for children aged 19-35 months in 1994 which quantified the association with poverty by showing that children who were below the poverty line had up to 13% overall lower immunisation coverage rates than other children (85). Matching these findings, Farizo et al reported in 1992 that coverage levels in the USA inner city areas were approximately 10-15% lower than state-wide (86). A case control study from 1998 on a measles outbreak in unvaccinated US pre-schoolers noted that under-vaccinated children were more likely to receive health care in the public sector, have single mothers, and have parents lacking knowledge of existing vaccines (87). A US record review of 2,648 children in first grade showed that low income children were the least likely to be adequately immunised, followed by middle income children, then high income children (88). Of note in this study was that the highest percentage of adequately immunised children was in high income children living in rural areas. Showing similar findings to the studies above, a US prospective cohort study that followed a cohort of 464 new-borns from a large teaching hospital identified a range of characteristics associated with under-vaccination - in particular poverty, urban living and single mothers (89). They concluded that *poor urban infants of single mothers, mothers who receive inadequate prenatal care, those not living with grandmothers should be targeted for tracking and follow up*. US research combining data from US national immunisation surveys from 1995 to 2003 noted the greatest impact on immunisation coverage was poverty leading to high rates of unimmunised children (85,89). When measured by state, those states with higher rates of uninsured children had six to sixteen times decreased childhood immunisation rates between 19 and 35 months of age.

There is now a significant body of research around immunisation coverage rates and barriers for obtaining high coverage in low income countries (66). The majority of these studies have identified poverty and the factors associated with poverty as significant barriers to obtaining higher immunisation coverage (75,78,80,90).

A cross-country publication analysed existing survey data from 24 countries in sub-Saharan Africa, covering 8,546 communities and 27,040 children aged 12 – 23 months over the period 2003 to 2010 (84). The study was designed to provide evidence of the contextual factors at the country and community levels that affect childhood immunisation coverage. Overall they showed that low immunisation coverage was associated with communities with high illiteracy rates and countries with high fertility rates. Children from the poorest households, uneducated parents, mothers with no access to media, and mothers with low health-seeking behaviours were most likely to be unimmunised. A 2008-2009 Kenyan health survey study identified the major contribution to inequality in receiving infant measles vaccination was socioeconomic; firstly, lack of household wealth, then mother’s education and ethnic group (72). The authors noted the barriers created by poverty include barriers to utilising maternal health services, high costs of services, poor transportation and inadequate health facilities for the poor, poor health decision making, insecurities in poor housing, and less education. Antenatal care attendance was strongly associated with immunisation uptake and this was consistently lower with women from poorer households. The subgroups that obtained the highest immunisation coverage were those in the richest quintile and parents with secondary or higher education; whereas those with the lowest coverage for measles vaccination were from the poorest quintile; of specific ethnic groups; had parents with no formal education; had unemployed fathers; lacked skilled antenatal care; and were from specific geographical areas. The poverty-related indicators were considered to be due to the direct effect of lack of household finances and to the parents' low education attainment. Finally, women from poorer households were more likely to have more children, exacerbating many of these other challenges.

With similar findings, a study utilising data from the 2004 Bangladesh national Demographic and Health Survey on 3530 infants showed only 60% of children in rural Bangladesh were fully immunised and the barriers to full immunisation included low family wealth, low education level of the mother, short birth interval, high parity, distance from health care facility, younger maternal age, effect of the mass media, female child, and maternal lack of tetanus toxoid vaccination in pregnancy (75).

Lower parental, particularly maternal, education has been identified in many surveys as affecting immunisation coverage (66) including in the Philippines (65), Pakistan (69), Nigeria (73), India (68,76,79,82), Bangladesh (75), Tanzania (77,78), Lebanon (81) and Uganda (67). Often alongside lower parental education were associated barriers around low awareness of immunisation programmes: misconceptions and misunderstandings around vaccines and fear of side effects (69-72,74). A Nigerian study designed to explore maternal beliefs interviewed 248 mothers who were traders in a large market town (73). Mothers who had no formal education were more likely to give reasons related to lack of motivation to take their child to get immunised than those with formal education.

Poor access to health care services, which is usually associated with poverty, has also been a commonly recognised association with low immunisation coverage, as identified in the Philippines (65), rural Pakistan (69), Bangladesh (75), and India (76,79). Other barriers commonly identified are birth order and spacing, number of children, physical access issues to health care services, and women as the head of the household, i.e. sole parents (77).

In Tanzania, a study following immunisation coverage across time noted that from 1990 to 2004 the percentage of children being fully vaccinated at a year of age remained similar (around 70 – 72%), but there were marked changes in disparities with a significant decline in immunisation coverage over time seen for children from the poorest strata and significant improvements in immunisation coverage for children from the wealthier strata (78). This highlights the importance of being aware of disparities in immunisation coverage and not just overall rates of coverage for a country.

An analysis which aggregated national Indian data over 2005 /2006 showed a significant link with poverty and low immunisation coverage with poor household economic status contributing just over a third of the total inequality and maternal illiteracy another third (68). Overall, the combination of poor household economic status, the mother being illiterate, the state domestic product, and the level of illiteracy at the state level contributed to 97% of the total socioeconomic inequalities in achieving full immunisation coverage.

An interestingly reverse trend has been described in a 2012 household cluster survey in Brazil which identified lower socioeconomic indicators in households as being associated with higher immunisation coverage with a 9% difference in coverage at 18 months of age for children from the lowest to the highest socioeconomic strata (64). The authors identified that Brazilian services had success in achieving higher immunisation coverage among poorer children, but needed more strategies to reach children in wealthier areas.

3.4.3.2 Geography-related barriers to obtaining high immunisation coverage

3.4.3.2.1 Results

There were 5 articles identified in this category. Refer Table 3.2.

Table 3.2: International studies since 2007 on the association between geography and immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Moisi 2010 (91)	Kenya	Observational: Survey in one district	2169 children aged 12 – 23 months	To identify predictors of immunisation coverage	>95% fully immunised for x3 DTP, 88% for measles	No problems with distance or travel times. Effective health services can overcome family barriers
Naeem 2011 (69,92)	Pakistan	Observational: Cross-sectional survey	Parents of 548 children aged less than 1 yr, urban and rural area	To identify factors related to vaccine failure or missed events	Urban coverage 76.5%, rural 48.8%	Urban barriers: lack of awareness, parents too busy, rural barriers: access to facilities, misconceptions
Toikilik 2010 (92)	Papua New Guinea	Observational: National survey	Parents/caregivers of children 12 – 23 months	To measure immunisation coverage and identify differences	48% urban immunised, 16% rural, 13% very remote, overall 4% immunised on time	Barriers to immunisation: rural and remote, distance, travel costs, misconceptions, lack of knowledge
Uddin 2009 (93)	Bangladesh	Observational: Survey, in-depth interviews, group discussions and observations	Children 12-23 months and their mothers, HCWs, rural region	To analyse immunisation coverage and identify alternative strategies in rural areas	No measurements	Barriers to immunisation completion: irregular/cancelled services, insufficient staff time
Wiysonge 2012 (84)	Sub-Saharan Africa	Observational: Combining survey data from 24 countries	27,094 children 12-23 months	To analyse factors affecting completion of childhood immunisation	21% variance due to country, 32% due to community level factors.	Barriers to immunisation completion: parents with no formal education, poor households, reduced maternal access to media, mothers with lower health seeking behaviour, communities with high illiteracy rates

3.4.3.2.2 Discussion

Variations in immunisation coverage, with different geographical areas achieving very different rates of immunisation coverage, are frequently identified in the literature. Refer Table 3.2.

Distance to health care service provision was identified historically in a 2007 study in Washington DC which collected data on the immunisation status and residential address of 4195 urban low income children aged 19 to 35 months and mapped their geographic accessibility to paediatric immunisation providers (94). The study found that those with the geographically closer proximity to providers had 36% higher odds of being up to date as compared with the lowest level of access. In contrast, a vaccine coverage survey in the Kilifi district of Kenya calculated travel time to vaccine clinics for 2169 enrolled children with a median age of 12.5 months and examined the relationship to immunisation coverage (91). They showed that travel time did not make a difference to vaccine update. The authors commented that the vaccination programme was effective at reaching children regardless of their geographical distance from the vaccine providers.

A study from Bangladesh focused specifically on geographical areas that had lower coverage and collected surveys, in-depth interviews and group discussions with families of children aged 12 to 23 months who lived in areas that had significantly lower immunisation coverage than the national coverage figures (93). The authors identified mainly healthcare service issues as the reasons for low coverage, identifying poorly organised irregular services particularly lacking strategic planning for remote areas.

Living rurally has been frequently identified as a barrier to immunisation coverage, such as reported in rural Bangladesh where Uddin et al comments that traditional service delivery is not sufficient to reach children in rural hard-to-access areas (93). By contrast the cross-country analysis from sub-Saharan Africa identified that children from urban areas overall were more likely to be unimmunised than those from rural areas (84). However, this is not consistent in all environments. In a cross-sectional survey undertaken in the region of Peshawar in Pakistan with interviews of 548 parents of children younger than one year (69), infants in rural areas had 27.7% lower immunisation coverage than those from urban regions. The study identified the challenges in the rural regions as being lack of accessibility to health centres, misconceptions about vaccination, and lower parental education levels, whereas reasons for non-immunisation in the urban regions were more the result of lack of awareness and parents being too busy.

Perhaps one of the most geographically-challenging regions in the world is Papua New Guinea and it is no surprise that their immunisation coverage survey 2009 on children aged 12 to 23 months identified rural and remote geographical location as being the most significant challenge to obtaining high immunisation coverage (92).

3.4.3.3 Barriers related to obtaining high immunisation coverage for minority ethnic, indigenous, and immigrant groups

3.4.3.3.1 Results

There were 7 identified articles in this category. Refer Table 3.3.

Table 3.3: International studies since 2007 on the association between immunisation coverage and minority ethnic groups, indigenous and migrant communities

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Guttmann 2008 (95)	Canada	Observational: Combining existing datasets	98, 123 children of new immigrants measured at age 2 yrs	To investigate access to primary care services in children of new immigrants	66.5% fully immunised, higher rates than non-immigrant population	Immigrant children had higher rates, variations by region of origin and SES
Hull 2011 (96)	Australia	Observational: Combining data sources for national report	All children 12 – 24 months	To report on immunisation coverage rates	Targets of >90% reached at 12 and 24 months	Delayed receipt of vaccines of delivery for indigenous children
Kusuma 2010 (97)	India	Observational: Cross-sectional survey,	764 rural-urban migrant mothers of children <2 yrs	To determine coverage and identify barriers for children of poor rural-urban migrants	Lower than national average	Barriers to immunisation: migrant status, younger mother, lower education status, less use of healthcare services, less HCW visits, non-secure income
Owino 2009 (72)	Kenya	Observational: Cross sectional descriptive survey, slums of large city	Parents of 712 children aged 12 – 23 months	To determine the factors influencing immunisation coverage	Access 95.6%, fully immunised 69.2%	Barriers to immunisation: maternal age, lack of record card, but not accessibility to services
Sensarma 2012 (79)	India	Observational: Cross-sectional survey of caregivers	256 caregivers of children 12-23 months, where a parent was HIV positive	To identify proportion of children living with HIV positive caregivers with complete immunisation	73% fully immunised, matching non HIV households in same area	Associations with lower coverage: maternal less antenatal care, lower education levels, Hindu and Christian, certain castes and tribes
Stojanovski 2012 (98)	Serbia	Observational: survey	469 Roma children 6-59 months of	To assess risk factors for low vaccination coverage among Roma children	Age appropriate immunisation 16% OPV and DTP, 14.3% MMR, 88% children had record cards	Importance of identifying high risk ‘invisible’ populations. Need for continuous, integrated comprehensive healthcare services
Sun 2010 (99)	China	Household cluster survey in 23 townships	Parents of 1820 migrant children 12 – 35 months	To evaluate immunisation status and determine risk factors for migrant children	83% immunised, but poor timeliness	Barriers to immunisation: child’s migrant status, primary caregiver awareness of immunisation importance, available outreach services, less supplementary immunisation activities in the region

3.4.3.3.2 Discussion

Children from minority ethnic groups and indigenous children have been identified in many studies as being at higher risk of under immunisation. Refer Table 3.3.

In the US, for many years immunisation coverage rates have been shown to be lower for Hispanic and Afro-American children (100). Findings of lower immunisation coverage and timeliness of delivery have not been consistent across all minority ethnic groups. For example, in Bradford, UK, immunisation coverage was shown to be higher in children of Indian and Pakistani ethnic groups than those of British descent (101). Immunisation rates are high for Australian aboriginal children, but timeliness of delivery has remained consistently lower than the Australian average (96).

A Serbian study, focusing on Roma children in disadvantaged areas in Belgrade, undertook a survey in 2009 among Roma households of 468 children between the ages of 6 – 59 months (98). They identified low immunisation coverage in this group, with the major risk factor for low coverage identified as children who were not registered with local authorities and therefore less likely to have vaccination record cards. The authors commented on the importance of identifying the ‘invisible’ populations and needing more efforts to integrate them into the health services.

In India, children from specific religious groups and castes are identified at risk of lower immunisation coverage. A community-based cross sectional survey conducted in the Kolkata metropolitan area assessed the predictors for children being fully immunised by 12 months of age and analysed data from 256 caregivers (97). Children of Hindu and Christian religions were 3.74 times less likely to be immunised (95% CI 1.63 – 8.62), and children not belonging to scheduled castes, tribes, or being seen as belonging to ‘backward classes’ were more than two times less likely to be immunised (95% CI 1.02 – 4.25).

When looking at challenges for immigrants, a Canadian study utilised linked administrative data sets in Ontario in 1997 and 1998, linking children to their mother’s records (95). They used logistic regression to assess immunisation status at the age of two years. With a study population of 98,123 children they showed that children of immigrant mothers were more likely to be fully vaccinated than children born to non-immigrant mothers (adjusted OR 1.15 with 95% CI 1.1 – 1.19). However within the immigrant group, children of mothers who were refugees had the lowest rates of coverage. When adjusted for maternal age, sex, neighbourhood income quintile, and health service characteristics, the region of origin of the mother was the most important predictor of coverage. Immigrants from Southeast and northeast Asia were most likely to be fully vaccinated (OR 1.63 with 95% CI 1.46-1.81). There was no association with the length of time since the mother had immigrated.

A Chinese household cluster survey was undertaken with caregivers of 1830 migrant children aged 12 – 35 months in 23 towns in Beijing who had much lower immunisation rates than non-migrants (99). The characteristics of the villages from which migrant children had come were significantly associated with lower immunisation coverage and, interestingly, the immunisation status of the child was very similar to those in the village of origin. The authors commented on the importance of being aware of the community context of the child.

When looking at literature from low income countries, a 2010 study from India undertook a cross-sectional survey of 746 migrant mothers who had migrated from rural to urban regions with a child under two years of age (79). They demonstrated that immunisation coverage rates were lower among migrants than the general population and lowest for the most recent migrants. Mitigating factors that reduced this effect were older mothers, higher educational attainment of the mother, secure work, and post-natal health care worker (HCW) visits.

3.4.3.4 Barriers related to obtaining high immunisation coverage related to child, family and community characteristics

3.4.3.4.1 Results

In total there were 20 articles identified in this category. Of these, 5 articles were identified as related to characteristics of the child; 11 related to parental characteristics; 3 related to family health beliefs, 1 related to communication and parental perceptions and 1 related to community confidence in vaccines. One article was used in two different subthemes. Results are presented in Table 3.4.

Table 3.4: International studies since 2007 on the association between child, family and community characteristics and immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Child characteristics						
Batra 2009 (102)	USA	Observational: Retrospective cohort analysis	127,833 children enrolled 0 – 12 months	To assess immunisation coverage in children of different birth weight categories	Immunisation rates 3-15% lower for low birth weight, 17-33% lower for very low birth weight than normal birth weight	Immunisation timeliness worse for low birth weight, caught up by 12 months except for very low birth weight
Ozkaya 2011 (103)	Turkey	Observational: Cross-sectional case control study	288 children <3 yrs and 190 in control group	To assess the impact of recurrent wheeze on immunisation status	OR incomplete vaccination 10.6 times higher in children with recurrent wheeze	Need to identify this group of children to maintain good immunisation coverage
Pandolfi 2012 (104)	Italy	Observational: Hospital-based Survey	275 children aged 6 months – 18 years with IDDM, Down Syndrome, cystic fibrosis or neurological diseases.	To assess the impact of chronic disease on immunisation coverage	DTP coverage 85%, MMR 62% at 24 months, considerable heterogeneity across diseases	Reasons for missing or delaying immunisation mostly due to concurrent acute disease
Rahman 2010 (75)	Bangladesh	Analysis of survey data	Rural children up to 5 years of age, national survey	To identify factors associated with complete immunisation status	Overall 60% of all children fully immunised	Associations with poverty: distance from services, birth interval too close, parity maternal age, mass media, female sex of child
Sensarma 2012 (79)	India	Observational: Cross-sectional survey of caregivers	256 caregivers of children 12-23 months, where a parent was HIV positive	To identify proportion of children living with HIV positive caregivers with complete immunisation	73% fully immunised, matching non HIV households in same area	Associations with lower coverage: maternal, less antenatal care, lower education levels; Hindu and Christian, certain castes and tribes
Parental characteristics						
Basaleem 2010 (105)	Yemen	Observational: Cross-sectional survey	Parents of 680 children, 12 – 23 months	To assess the immunisation status	83.1% fully immunised, 10.4% partial, 6.5% never	Associations with low immunisation: no immunisation record cards, younger mothers
Kusuma 2010 (97)	India	Observational: Cross-sectional survey	764 rural-urban migrant mothers of children <2 yrs	To determine coverage and identify barriers for children of poor rural-urban migrants	Lower than national average	Barriers to immunisation: migrant status, younger mother, lower education status, less use of healthcare services, fewer HCW visits, non-secure income
Oladokun 2009 (106)	Nigeria	Observational: Cross-sectional survey	418 female traders in urban region with children 12-23 months	To identify factors for children being at risk of low immunisation	Full immunisation 40.7%,	Low coverage overall for children of traders

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Owhino 2009 (72)	Kenya	Observational: Cross sectional descriptive survey, slums of large city	Parents of 712 children aged 12 – 23 months	To determine the factors influencing immunisation coverage	Access 95.6%, fully immunised 69.2%	Barriers to immunisation: maternal age, lack of record card, but not accessibility to services
Rahman 2010 (75)	Bangladesh	Observational: Analysis of survey data	Rural children up to 5 years of age, national survey	To identify factors associated with complete immunisation status	Overall 60% of all children fully immunised	Associations with poverty, distance from services, birth interval too close, parity maternal age, mass media, female sex of child
Sahu 2010 (76)	India	Observational: National survey data analysis	Children nationally 12 – 23 months	To identify factors behind low immunisation coverage	Not reported	Low coverage associations with lower parental education, child birth order, no antenatal care, lack of healthcare facilities, less promotion and communication activities
Sun 2010 (99)	China	Observational: Household cluster survey in 23 townships	Parents of 1820 migrant children 12 – 35 months	To evaluate immunisation status and determine risk factors for migrant children	83% immunised, but poor timeliness	Barriers to immunisation: Child's migrant status, primary caregiver awareness of immunisation importance, available outreach services, less supplementary immunisation activities in the region
Salmon 2009 (107)	USA	Observational: Analysis of national immunisation survey data	Children up to 5 years, measuring points in time	To look for associations between maternal age and preschool immunisation coverage	Children of 17 yr old mothers 64% complete, mother 18-26 80.3%.	Lower coverage for young mother, no change in coverage for mothers over 26 years of age
Stein-Zamir 2012 (108)	Israel	Case control for an outbreak investigation	Children < 5 yrs with measles	To analyses low immunisation coverage in a measles outbreak in Jerusalem	DTP3 coverage 48.6%. MMR1 80.8%.	Higher rates of measles in children not registered in well baby clinic and with rising birth order
Tobin-West 2011/12 (109)	Nigeria	Observational cross sectional survey	1560 mothers of children 0 – 5 yrs	To identify barriers to childhood immunisation	46.8% of the children of sampled mothers had not completed their immunisation	Immunisation knowledge was low, frequent shortages of vaccines in health facilities
Wiysonge 2012 (84)	Sub-Saharan Africa	Observational: Combining survey data from 24 countries	27,094 children 12-23 months	To analyse factors affecting completion of childhood immunisation	21% variance due to country, 32% due to community level factors.	Barriers to completion of immunisation: Parents with no formal education, poor households, reduced maternal access to media, mothers with lower health seeking behaviour, communities with high illiteracy rates

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Family Health Beliefs						
Diekema 2012 (110)	USA	Summary article	N/A	To review immunisation rates and identify barriers	N/A	Barriers to be overcome: poverty, exemptions to school-entry rules, misinformation, changing clinician communication style
Schonberger 2012 (111)	Germany	Observational survey	Parents of 3041 children who had been offered MMR vaccine	To investigate factors affecting parental decisions on child immunisation	53% of sample had received MMR1 and 42.9% MMR2 on time	Children with higher chance of immunisation with parents who considered vaccines important and protective, barriers with parents who had been advised by alternative practitioner, fear of vaccines.
Sun 2010 (99)	China	Observational: Household cluster survey in 23 townships	Parents of 1820 migrant children 12 – 35 months	To evaluate immunisation status and determine risk factors for migrant children	83% immunised, but poor timeliness	Barriers to immunisation: child's migrant status, primary caregiver awareness of immunisation importance, available outreach services, fewer supplementary immunisation activities in the region
Communication and parental perceptions						
Ahlers-Schmidt 2012 (112)	USA	Observational: Convenience sample interviews	50 parents of immunised children	To investigate parental perceptions of different forms of communication for children's vaccines reminders	No measures	Most parents satisfied with traditional communication: face-to-face and telephone. Receptive to text as a form of communication
Community confidence in vaccines						
Larson 2011 (113)	UK	Review article	N/A	To review and advise on public confidence in immunisation programmes	N/A	Listed key messages and recommendations

3.4.3.4.2 Discussion

There are a range of child and family characteristics that have been identified as associated with immunisation coverage. Refer Table 3.4.

Child characteristics

I. Low birth weight

A US retrospective cohort analysis of computerized vaccination data from a large managed care organization in California identified 127,833 infants during the study period, of whom 6491 were low birth weight and 788 very low birth weight (102). Age-appropriate vaccination rates were 3 to 15% lower for low birth weight infants and 17 to 33% lower for extremely low birth weight infants. By twelve months of age the low birth weight infants had caught up, but vaccination rates were still delayed for children of very low birth weight.

II. Illness

A Turkish cross-sectional case control study reviewed 288 children under three years of age who had a history of recurrent wheezing, compared to a control group of 190 children (103). They compared vaccination charts and showed that there was a significant inverse association between the number of wheezy episodes and the number of vaccines given. Children with recurrent wheeze overall were 10.6 times less likely to be fully vaccinated (95% CI 2.96- 38.1). Similar findings were seen in an Italian study which measured immunisation coverage and timeliness in children with type one diabetes, HIV, Down syndrome, cystic fibrosis, and neurological disease (104). They reviewed 275 children aged 6 months to 18 years and showed heterogeneity among children with different chronic diseases. Overall, children with HIV and neurological conditions had the longest delays in receiving vaccinations. The major causes for delay or missing a vaccination event were concurrent acute illness.

III. Female sex

In some low-income countries there is an association with female children having lower rates of immunisation as reported in Bangladesh (75) and India (79). However the relationship with female sex is not consistent across other Indian studies (82).

IV. Parental characteristics

Parental age and parity

In low income countries many studies have identified younger mothers as being less likely to have fully immunised infants (72,75). A cross-sectional survey in Yemen found that younger mothers were 40% less likely to have fully immunised infants for the primary course of three than older mothers (105).

Parity and birth spacing also have an effect on immunisation coverage, particularly in low-income countries. Generally, children later in the birth order are less likely to be immunised, as are children from families where there is a short birth interval (75,76). Even in higher income countries increasing parity has been identified as a barrier, as is seen in an Israeli study investigating a measles outbreak in Jerusalem in 2007-2008 where they identified one of the risk factors for non-immunisation with the MMR vaccine being rising birth order (108).

Parental occupation

Many studies have identified parental work/income as an issue affecting immunisation coverage. While generally parents in stable work are more likely to have fully immunised children (114), an interesting study in Nigeria reviewed immunisation completion rates of children aged 12 – 23 months of 418 female market traders in the Nigerian city of Ibadan (106). This revealed that these children had significantly lower immunisation completion rates which the authors concluded was due to the parents being too busy and there was need for outreach immunisation sites at the markets.

V. Family health beliefs

While not considered to be as strong an association as the other areas already identified, some family health beliefs have been historically identified as associated with low immunisation rates. A commentary by Grabowksi et al in 1996 noted that parental (and provider) attitudes about immunisation do not appear to be significant barriers for the majority of under-immunised pre-schoolers (115). However a US cohort study identified that parents who perceive susceptibility to common symptoms, and those who perceive the benefit of medical care are more likely to have immunised children (89). There were no other health beliefs in this study that significantly correlated with immunisation uptake.

Historically, it has been identified that anti-immunisation parents may group in community pockets or geographic areas and they can contribute to low coverage and resultant high disease in certain defined geographic areas and groups (107,116). Public awareness of controversies also can have significant impacts on the public confidence in vaccinations leading to reductions in immunisation coverage. A particularly powerful historical example of this effect is recorded in the article by Gangarosa et al which records the impact of the controversy around the whole cell pertussis vaccine in the 1980s where there was a widespread concern around the safety of the vaccine (117). This study recorded dropping vaccination rates in eight high income countries compared to four countries where the controversy did not have an impact. Pertussis incidence was 10 to 100 times lower in the countries where high vaccine coverage was maintained compared to the countries where immunisation programmes had lower vaccination rates as a result of the fears around side effects. Historic research from the UK identified parents who chose not to immunise their children as more likely to hold religious beliefs affecting their views; have a preference for homeopathy (118); have concerns that the potential risks of the vaccine outweighed the risks of contracting the disease (119); and may perceive that health professionals provide unbalanced information (117).

The cross-country study from sub-Saharan Africa has identified that there were clustering effects of non-immunisation at the community level, such that children from the same communities tended to have the similar immunisation status (84). This finding is the same as the Chinese study where migrant children had similar immunisation status to the village from which they had originated (99). This highlights that children in the same neighbourhood are likely to be subject to common influences.

Anti-immunisation parents in the US are around 1-3% of the total population, so are not considered a sizable contribution to low coverage. In a review article Diekema points out that the greatest gains are to focus on children whose parents are open to vaccination but encounter barriers or hesitate due to safety concerns rather than absolute opposition to the principle of immunisation (110). A German study of parents of 3041 children in 2010 identified that parents who considered vaccines important and protective in association with being given advice by the consulted physician were significantly more likely to have vaccinated children than parents who were afraid of vaccinations or were advised by an ‘alternative practitioner’ (111).

In sub-Saharan Africa systematic reviews suggest that parents and communities lack knowledge of immunisation and often have poor access to information on childhood immunisation (84). This affects health-seeking behaviour which can translate into lower rates of immunisation coverage.

VI. Communication and parental perceptions

A recently published US study undertook structured interviews with fifty parents to assess parental awareness and satisfaction with various forms of communication around the childhood schedule (112). In this study all the parents had face-to-face contact with the child’s family doctor, 74% had telephone contact, and none used email or text messages. While the majority were satisfied with face-to-face contact (96%) and telephone (75%), overall 98% (49/50) were interested in receiving immunisation reminders by text message and all were willing to receive general reminders by text message. No barriers to this method of communication were identified by the parents.

VII. Community confidence in vaccination

A 2011 commentary article discusses the challenges with loss of public confidence in vaccination, public concerns around vaccine safety and concerns about backlashes following success with vaccination programmes and the effective international reach of the modern media with the internet and social networking (113). There are three identified components to the extent to which an individual or institution is trusted. These are the perceptions of:

- Knowledge and expertise.
- Openness and honestly.
- Concerns and care.

Public decision-making is driven by a combination of scientific, economic, psychological, sociocultural, and political factors, all of which need to be understood and taken into account by policy and other decision-makers (113).

3.4.3.5 Health System factors that have an impact on immunisation coverage

3.4.3.5.1 Results

There was one overview article identified; 3 articles related to measuring and monitoring; and 12 articles related to systems at the provider level giving a total of 16 articles. Results are presented in Table 3.5.

Table 3.5: International studies since 2007 on the association between factors in the health system and immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Overview						
Hyde 2012 (120,121)	International	Systematic Review	Six databases, 15,795 articles sourced 1911 to 2010, 130 articles reviewed.	To examine the impact of new vaccine introduction on countries' immunisation and broader health systems	Variable	New vaccine introduction most efficient when fitted into an existing delivery system and in combination with routine schedule. Barriers: cold chain capacity, training and education for HCWs
Measuring and Monitoring						
Chin 2012 (121)	Australia	Observational: Reporting on National Register data	Children up to date for any childhood immunisation event	To report on linkage of immunisation registers with health outcome data	91.8% fully immunised at 12 months, 92.6% at 24 months	Data linkage of registers is effective population-level reporting
Chandran 2011 (122)	India	Observational: Combined data from national surveys	Children in Andhra Pradesh region 12 – 23 months	To analyse factors responsible for low immunisation coverage	Variable results	Concerns with data accuracy, probably due to problems with data collection methods
Haddad 2010 (123)	Burkino Faso	Observational: Combined data from administrative sources and EPI cluster survey	Children fully immunised following completion of primary infant series	To assess the validity of immunisation estimates for planning and monitoring activities	Coverage rates for DTP3 similar for 2 data sets – 71% vs 74% and measles 68% vs 64%	Significant variability in coverage across districts with over and underestimations of coverage. More underestimation in highly populated urban regions
Systems at the Provider level						
Basaleem 2010 (105)	Yemen	Observational: Cross-sectional survey	Parents of 680 children, 12 – 23 months	To assess the immunisation status	83.1% fully immunised, 10.4% partial, 6.5% never	Association with low immunisation: no immunisation record cards, younger mothers
Lorenz 2012 (124)	Pakistan	Observational, cross-sectional combining survey data	Household economic survey data for 3 periods: 1998-1999;2001-2002;2005-2006	To assess health system reasons for non-vaccination of children	No coverage measure	The authors estimated that 75% of non-vaccination could be solved by use of mobile vaccination teams
Odusanya 2008 (70)	Nigeria	Observational: Cross-sectional survey, rural region	339 mothers of children 12-23 months	To assess determinants of vaccination coverage	Coverage 61.9%. 99% positive attitudes, 55% knowledgeable re VPDs,	Associations with high coverage: maternal knowledge, privately funded facility
Opwora 2011 (71)	Kenya	Observational: Questionnaire, parents and HCWs	397 caregivers of children <5 yrs leaving healthcare service, 45 key informants	To investigate barriers to accessing healthcare services	No immunisation coverage measure	Association with barriers to access healthcare services: long waiting times, perceived poor services, incompetence, poor HCW attitudes

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Owino 2009 (72)	Kenya	Observational: Cross sectional descriptive survey, slums of large city	Parents of 712 children aged 12 – 23 months	To determine the factors influencing immunisation coverage	Access 95.6%, fully immunised 69.2%	Barriers to immunisation: Maternal age, lack of record card, but not accessibility to services
Pereira 2012 (125)		Systematic review, 10 articles included	Healthcare providers	To identify providers' perceived barriers to the use of recall/reminder systems	N/A	Human and financial resources major barrier: Others included low confidence in record accuracy, lack of data sharing, staff changes and workflow, electronic functionalities.
Roberts 2011 (126)	US	Observational: Survey and observational visits	HCWs in six Paediatric practices,	To identify key components in strategies for quality improvement for immunisation delivery	variable	Barriers to effective immunisation coverage: Provider practices, particularly lack of accurate records and prompting
Sia 2009 (80)	Burkino Faso	Observational: Combining survey data and questionnaire, 2 time periods	805 and 1360 children 12-23 months in 48 rural districts	To identify individual and systemic factors associated with complete immunisation coverage	An increase in coverage from 25.9% in 1998 to 41.3% in 2003. 7.4% regional variance	District resources no effect. Education initial effect, declined over time. Barriers: poverty, healthcare, less utilisation of healthcare services. Continuing from antenatal care important
Sinno 2009 (81)	Lebanon	Observational: Random selection chart review	774 children and 154 parents enrolled in health insurance plan,	To describe predictors of compliance with the immunisation schedule	54.6% fully immunised by 4 yrs	Associations with lower coverage: Older children, low maternal education, use of other health care facilities
Stein-Zamir 2012 (127)	Israel	Case control for an outbreak investigation	Children < 5 yrs with measles	To analyses low immunisation coverage in a measles outbreak in Jerusalem	DTP3 coverage 48.6%. MMR1 80.8%.	Higher rates of measles in children not registered in 'well baby' clinic and with rising birth order
Stojanovski 2012 (98)	Serbia	Observational: Survey	469 Roma children 6-59 months of	To assess risk factors for low vaccination coverage among Roma children	Age appropriate immunisation 16% OPV and DTP, 14.3% MMR, 88% children had record cards	Importance of identifying high risk 'invisible' populations. Need for continuous, integrated comprehensive healthcare services.
Tobin-West 2011/12 (109)	Nigeria	Observational cross sectional survey	1560 mothers of children 0 – 5 yrs	To identify barriers to childhood immunisation	46.8% of the children of sampled mothers had not completed their immunisation	Immunisation knowledge was low, frequent shortages of vaccines in health facilities

3.4.3.5.2 Discussion

Of all the identified factors, most likely to be of greatest importance in obtaining high immunisation coverage is the role of the healthcare system and the front line providers who promote and deliver immunisation–their policies, governance, systems, quality assurance, as well as the knowledge and attitudes of the providers themselves, all appear to be core aspects (128).

An effective health delivery system needs to allow the delivery of the immunisation schedule to be convenient and easy to access for every child. For an effective delivery system there are many governance, systemic, and performance issues that need to be in place (129)

A 2012 publication from the US aimed to qualitatively review local health department immunisation programmes to identify specific organisational factors underlying challenges and successes in performance (125,126). The study undertook case studies on convenience samples from 17 geographically and demographically diverse local health departments across the country. They found two thematic dimensions around factors in success and those in change elements. The organisational factors that were associated with success and challenges were characterised in six areas:

- Leadership – including management leadership for immunisation services and with aligning to other child-focused services.
- Resources – including effective financing approaches.
- Politics – political advocacy in addition to community and local political and health stakeholder partnerships and coalitions.
- Community engagement – including coalitions and partnerships.
- Credibility – agency credibility and its ability to influence community attitudes.
- Cultural competency of the staff.

The authors concluded that particularly the internal aspects of local health departments, such as leadership and organization culture, are likely to have significant impacts on immunisation coverage rates

The challenges with the health delivery systems are often more clearly recognised when new vaccines are introduced into the system. A systematic review of the literature published in 2012 identified 15,795 articles, of which 130 were found to be relevant to the topic, the majority of which were related to high income countries (120). Of particular importance here also was that new vaccine introduction does not appear to impact coverage of vaccines already included in the schedule. The challenges highlighted were particularly cold chain capacity, training and education of HCWs, and social mobilisation.

Measuring and Monitoring

Knowing the immunisation coverage as a community, to be able to measure, monitor, and report is a significant part of a functioning system. Many countries, particularly those characterised by low income, struggle with a lack of accurate data for monitoring. There are many different ways of managing this in countries, but probably the most effective is via the use of immunisation registers. The Australian experience with the ACIR (Australian Childhood Immunisation Register) demonstrates the strength of being able to know an individual's immunisation history, and use aggregate data for monitoring and responding. This register still has a range of limitations in data quality and contains no vaccination records for children beyond seven years of age (121).

One significant challenge for low income countries is having effective tools and systems to accurately measure immunisation coverage rates. An Indian study identified their greatest challenges as being issues around measuring coverage with lack of standardisation around data collection, age groups, methodological difference, and different levels of commitment and skill sets of the investigators (122). Similarly, a study from Burkino Faso mapped significant variability in immunisation coverage across districts which did not match with findings from their national EPI cluster survey results. There were large discrepancies with a mixture of under and over reporting, with the differences reaching as high as 30% in some districts (123). The authors highlighted the challenges in using nationally aggregated data with decentralised systems.

Systems at the provider level

There is a large body of historical literature that identifies many of the barriers at the provider level. While systems vary internationally, there are commonalities in immunisation administration which apply from the literature. Key aspects of the delivery system from the historical review that have been identified to impact on immunisation coverage include:

- Vaccine shortages (130,131).
- Vaccine costs and availability (130,132).
- Incomplete vaccination records (130,132-134), poor/incorrect or no documentation (130,135,136).
- Lack of or inadequate recall/reminder systems and tracking systems (136).
- Continuity of care (137).

Many of the above factors impact the ability to deliver immunisation in a timely fashion. It appears that particularly the delivery of the first event is important to subsequent completion of the immunisation programme. Delay in receipt of the first immunisation has been historically recognised as a consistently strong predictor of subsequent delayed or missed immunisation (86,121,130). Williams et al demonstrated a 5.6 times higher risk of not being up to date at a year of age if the infant was delayed in receiving the first immunisation event (88). The importance of continuity of provider care was demonstrated by looking at the association with preventive child health visits and immunisation coverage. Children who have more frequent Well Child visits are more likely to be fully immunised and immunised on time (138). Wood et al demonstrated that each additional Well Child visit increased the odds of the children being fully immunised at 24 months, whereas additional sick children visits did not increase these odds (138).

More recent literature has particularly reinforced the importance of functioning tracking, recall, and reminder systems. A systematic review of literature from 1990 to 2011 focused on providers' perceived barriers to the use of recall/reminder systems (125). Ten articles were identified and reviewed over this period. The most frequently perceived barrier to effectively implementing recall and reminder systems was the perceived human and financial resource constraints, followed by lack of confidence in the accuracy of patient immunisation records due to lack of data sharing between multiple immunisation providers. The barriers identified included changes to staff workflow, lack of appropriate electronic patient-tracking functionalities, and provider uncertainty around the success of recall/reminders as interventions. Identification and recall both need to include effective information transfer between providers.

The importance of registration, enrolment, and regular contact with providers and continuity of care is highlighted in several studies. For example, when analysing a measles outbreak in the Jerusalem district of Israel in 2007/2008 children who were unimmunised for the measles vaccine were much less likely to be enrolled in well baby clinics (108). This issue is also graphically illustrated with the Serbian study on Roma children that highlighted the main barrier to immunisation coverage was lack of engagement in the healthcare services with families who had not registered their children with the civil authority at birth and hence were not engaged in any continuous or comprehensive healthcare service (98).

Utilising data from surveys and statistical year books in Burkino Faso from the years 1998 and 2003, this study notes that immunisation coverage of children was improving despite the fact that the overall poverty was worsening (80). The most significant explanatory factor identified behind this improvement appeared to be continuity of health care from antenatal care through to postnatal and child care. The authors concluded that stable continuing care creates a loyalty to health care services and healthcare service utilisation needs to be seen as the result of a dynamic process of interaction between communities and the healthcare system. Supporting this finding, a study from Lebanon noted that maternal use of other health care facilities was associated with lower immunisation uptake for children as measured by the age of 4 years (81).

The type of health care facility can also make a difference to immunisation coverage, depending on the country of context. A Nigerian study in 2006 in a rural community found higher rates of immunisation coverage for children aged 12 – 23 months when their mothers attended privately funded health facilities (70).

A significant challenge for systems, particularly from low and middle income countries, regards knowing the child’s immunisation status, and having records available and accessible. A cross-sectional survey in Yemen identified the lack of immunisation cards as a factor in low immunisation rates with children who had health record cards being 14.7 time more likely to receive the primary course of three vaccination events (95% CI 8.5 – 25.4) (105). Similar findings from a survey on 712 children from a slum area in central Nairobi, Kenya showed that immunisation coverage was significantly lower for children whose parents left their health record cards at home (p-value <0.001) (72). Furthermore, having some approach to informing parents when to return for the next vaccination is also often missing in delivery systems (72,81). In Lebanon low immunisation coverage is associated with incorrect parental perceptions of immunisation status with no available records (81).

None of these issues act in isolation. A US study from 2011 aimed to identify the key components of the immunisation process at the primary care level by observing six paediatric practices in South Carolina, using both survey questionnaire and direct observation of immunisation delivery processes and patient charts (126). Considerable variation was seen among and within practices. There was significant variation between what practices stated they did and what actually happened: Four practices stated that they prompted the immunisation at sick-visits but only one did so. Most practices had multiple forms and administered vaccines were not always recorded on all forms making it difficult to accurately determine immunisation coverage. The authors noted that direct observation of immunisation processes and medical record review is an important quality improvement tool to assist with systems improvements for immunisation delivery. This study particularly highlights the gap between perceptions of systems and the actual functioning of the system.

A range of quality service issues impact on the ability to vaccine children. A Kenyan study conducted interviews of 397 caregivers in six public health facilities and identified a range of healthcare facility barriers as being much more important to immunisation uptake than parental issues (71). The barriers included long waiting times, poor services, and perceived poor attitudes and incompetence of the healthcare workers

3.4.3.6 Health provider factors that have an impact on immunisation coverage

3.4.3.6.1 Results

There were five identified in this category. Results are presented in Table 3.6.

Table 3.6: International studies since 2007 on the association between factors with the health provider and immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Becton 2008 (139)	USA	Observational: Collation of survey data, 2 time points	Children 19-35 months from 50 States	To assess changes in paediatrician number, poverty levels and health insurance effects on immunisation coverage	Coverage increase from 52.5% to 79.8% over 8 years	Barriers to immunisation coverage: fewer paediatricians in an area, uninsured children
Gargano 2012 (140)	India	Observational: Phone/mail survey	505 Paediatricians, 773 PHC physicians	To determine attitudes of HCWs in primary care centres to routine immunisation and identify correlates of missed opportunities	PHC physicians 50 – 70% less likely to immunise if they thought another HCW was responsible	Key barriers to immunisation coverage include HCW perceptual barriers and considering themselves not responsible
Herzog 2013 (141)	Developed countries	Systematic search	15 studies	To determine the relationship of HCW knowledge, attitudes and beliefs on intention to immunise	Not shown	Higher awareness beliefs are aligned with scientific evidence and greater intentions to immunise
Owhino 2009 (72)	Kenya	Observational Cross sectional descriptive survey, slums of large city	Parents of 712 children aged 12 – 23 months	To determine the factors influencing immunisation coverage	Access 95.6%, fully immunised 69.2%	Barriers to immunisation: maternal age, lack of record card, but not accessibility to services
Schonberger 2012 (111)	Germany	Observational survey	Parents of 3041 children who had been offered MMR vaccine	To investigate factors affecting parental decisions on child immunisation	53% of sample had received MMR1 and 42.9% MMR2 on time	Children had higher chance of immunisation with parents who considered vaccines important and protective, barriers with parents who had been advised by alternative practitioner, fear of vaccines.

3.4.3.6.2 Discussion

The role of the health provider is seen as fundamental to the success of any vaccination programme. A US commentary in 1996 stated that the characteristics of the vaccination provider *were more closely associated with vaccination coverage levels than were the characteristics of the family and child* (133).

Healthcare provider attitudes have been identified as one possible barrier to gaining high immunisation coverage. A systematic review published in 2013, identified 2354 references between 1998 and 2009, of which 15 met the inclusion criteria for assessing healthcare workers' knowledge, beliefs and attitudes (141). One retrospective case-control study showed a causal link between beliefs, attitudes, and intentions to vaccinate, but none of the other studies established a causal relationship between these variables. All studies showed that healthcare workers with greater knowledge of vaccines and beliefs that were more aligned with scientific evidence had more favourable attitudes towards immunisation. However, it was not possible overall to show causal relationships.

An interesting study from India identified the importance of health provider personal engagement. These authors undertook a phone/mail survey of primary healthcare physicians in Uttar Pradesh and Bihar (140). This study had a 95.7% response rate giving a sample size of 719 physicians. Results showed that physicians who held other HCWs primarily responsible for vaccination were 50 to 70% less likely to vaccinate a child themselves. The Kenyan study from the slum areas of Nairobi demonstrated that parents who considered healthcare providers to have negative attitudes were less likely to have fully immunised children (72).

A 2010 German study also highlighted the importance of the role of the health provider attitudes. In reviewing parental attitudes with parents of 3041 children, it was found that parents who were advised by the consulted physician of the importance of vaccination as protective were more likely to get their children vaccinated, whereas parents who consulted 'alternative practitioners' who did not support vaccination were more afraid of vaccinations and less likely to immunise their children (111). The authors comment that medical advice plays an important role in immunisation coverage and the timeliness of delivery.

Having an adequate number of providers was identified as a positive factor for immunisation coverage in the US study utilising combined data from the national immunisation surveys from 1995–2003. This study showed that the states with the highest immunisation coverage rates had higher numbers of paediatricians (139). States with higher numbers of paediatricians had a fourfold higher rate of immunisation coverage overall.

3.4.3.7 Recommendations around how to overcome barriers to obtaining immunisation coverage

3.4.3.7.1 Results

There were 6 articles in this category that gave summary recommendations across all the themes. Results are presented in Table 3.7.

Table 3.7: International studies since 2007 focusing on recommendations for overcoming barriers to obtaining high immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Kennedy 2010 (142)	USA	Observational: Qualitative analysis, semi structured interviews	95 interviews with key providers and staff in immunization programs	To describe activities of state and local programs that sustain high coverage across several years and identify themes	Not measured	Effective interventions include strong program infrastructure, available data for planning and decision-making, commitment to relationships, focus on education, and communication
Larson 2011 (113)	USA	Commentary, literature review	N/A	To discuss the characteristics of the changing global environment contributing to public confidence in immunisation programmes	N/A	Barriers to immunisation coverage include a mix of factors affecting public trust – psychological, social, and political
Naimoli 2008 (143)	Ghana, Rwanda, Malawi, Ethiopia, Mauritania, Cameroon	Observational: Qualitative inductive inquiry using survey data, key informant interviews	Survey data children < 5 yrs for DTP3; key informants in immunisation programmes	To investigate why some programmes are more successful than others in sub-Saharan Africa	Medium coverage 58%, significant variability	Different pathways to success. Barriers to immunisation coverage include contextual challenges and the larger health system
Olafsdottir 2011 (61)	46 countries	Observational: Ecological analysis of cross sectional data	Measuring under 5yrs mortality rate	To examine relationship between health systems outcomes and equity	N/A	Barriers to high performing health systems include quality of the governance
Van Malderen 2012 (90)	Kenya	Observational: Combining survey data, 3 time periods	Children under 5 years stratified by region, urban/ rural	To analyse socioeconomic inequalities in use of skilled birth attendance and measles vaccination uptake	Overall reduction in measles coverage explained 40% by wealth index, 28% by parental education, 9% by antenatal care, 33% by birth order, -19% by rural	Barriers to higher measles vaccine coverage were primarily poverty driven, and included parental education, birth order, and urban residence

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Wiysonge 2012 (84)	Sub-Saharan Africa	Observational: Combining survey data from 24 countries	27,094 children 12-23 months	To analyse factors affecting completion of childhood immunisation	21% variance due to country, 32% due to community level factors.	Barriers to completion of immunisation: parents with no formal education, poor households, reduced maternal access to media, mothers with lower health-seeking behaviour, communities with high illiteracy rates

3.4.3.7.2 Discussion

The 2008/2009 Kenyan study that identified multiple barriers to improving immunisation coverage for measles vaccine around geography, poverty, and health care services recommended the importance of fitting interventions into the socioeconomic and political context of the environment (90). Broader determinants need to be considered around improving the standard of living, education standards, involving the population in decisions, effective mobilisation, and allocation of resource and community strategies to enhance community access to health care.

A 2008 article explored reasons why some immunisation programmes in sub-Saharan African are more successful than others (143). They utilised methodology from performance benchmarking and what they described as positive deviance inquiry (based on a grounded theory approach) to explore differences in six countries. The authors comment that traditional advice given to countries about improving routine coverage tends to be informed as much by ideology and conventional wisdom as it is by systematic evidence of what works in different settings under different conditions. The methodology adopted four core functions to guide data collection: supply, demand, financing, and the governance/institutional framework. They undertook multi-phased purposeful sampling in the selected countries, focusing on coverage of children under 5 years of age over the period 1997 to 2002. Two high performing (Ghana and Rwanda), one medium (Malawi) two medium-low (Ethiopia and Mauritania) and one low performing country (Cameroon) were selected. Overall, there was significant heterogeneity in how immunisation programmes were delivered. Key generalisable findings were that the high performing countries had robust implementation of programmes with good governance, good institutional frameworks, reasonably good management and delivery, and stable financing and demand. There are different local models to achieve this same successful outcome. Performance-based incentives, which are flexible to locally identified needs, appear to be effective e.g. the (Global Alliance for Vaccines and Immunisation) GAVI Immunization Services Support initiative.

Governance working well with institutional frameworks is vital to sustained success. The traditional core areas of immunisation programmes – management, service delivery strategy, and demand – need to remain at the centre of attention for planning. It was noted that despite often similar challenges some countries can overcome common problems such as human resources, transport difficulties more successfully than others. Global health partnerships are becoming an increasingly important part of the system functioning. The authors also noted the considerable variability in outcome within countries and the importance of exploring why some districts are more successful than others. Finally they commented that the solutions to overcoming challenges to sustaining high immunisation coverage do not reside just within the NIPs but need to be set within the greater contextual challenges of the large health systems.

Supporting these findings, an ecological analysis utilising cross-sectional data from 46 countries in the African region identified the quality of the governance as being the most important structural determinant of the performance of the health system for reaching the millennium development goals of reducing mortality for those under 5 years (61).

Identifying the same general themes, the cross-country review from sub-Saharan Africa highlights the need to take a systematic approach to the overall immunisation programme in a country (143). When reviewing all the barriers to gaining higher immunisation coverage, 21% of overall barriers were considered to be country–related factors and 32% overall related to local community factors. This study suggests multifactorial issues need addressing: low parental and community knowledge of immunisation, lack of access to information alongside systematic approaches to providing better systematic services to families via provider-level reminder, and recall systems alongside mass media interventions.

When reviewing from the perspective of a high-income country perspective, qualitative analysis reviewed activities across USA state and local immunisation programmes and described activities that both sustained higher coverage levels across several years and identified common themes and practical examples for sustaining coverage that could be used for application elsewhere (142). The study involved 95 semi-structured key informant interviews with internal staff members and external key stakeholders with 10 immunisation programmes that had the higher immunisation coverage rates from 2000 to 2005. The common themes identified to successfully sustain immunisation coverage included: maintaining a strong programme infrastructure; effective use of data to drive planning and decision-making; commitment to building and sustaining relationships; and focusing on education and communication.

Finally, concentrating on how to maintain confidence in immunisation programmes, Larson et al summarised the current thinking with five suggested points which I list here (113):

I. *Recognising the heterogeneity of populations and local concerns and trust relations, build locally tailored strategies to the needs of various stakeholders.*
II. *Use evidence-based approaches in risk communication as core principles at all levels. This needs to include principles of transparency and honesty about uncertainty and risk.*
III. *Take a systematic approach to listen to public concerns; surveillance is essential for systematic monitoring and responding to vaccine rumours and concerns.*
IV. *Recognise the importance of social science and decision science research.*
V. *Use models of multidisciplinary research that includes technical, operational assessments and research into social and political factors for planning the introduction of vaccines*.

3.4.3.8 Barriers to improving immunisation coverage: Conclusions

From the literature reviewed it is apparent that the ability to obtain and maintain high immunisation coverage has an interwoven mixture of factors related to the environment, the family and community context, the political context, the healthcare system and the healthcare providers.

With the social and family context, the issues for a family living in a more economically-deprived situation appear to create significant barriers to obtaining good immunisation coverage in a community. The effects of economic deprivation are multiple and include financial barriers to affording and physically accessing healthcare services for maternal and infant care. However there are many other challenges with living in deprived situations such as the effect of parental low literacy on awareness of the importance of vaccination and reduction in misconceptions and fears; reduced access to media and other sources of information; reduction in usage of healthcare services reducing continuity of care and relationships with services; high parity; and short birth intervals creating challenges for obtaining healthcare services. However, recognising all these challenges, a system can instigate mitigating factors to reduce or overcome them. Such responses would be at many levels. Firstly, responses can stem from the higher political commitment to reduce inequalities, work and social services' responses to security of incomes, employment and improving parental education. Secondly, responses can occur on the level of healthcare services, including: responding to environmental challenges with accessible healthcare services outreach services and social challenges with engaging services, effective health service engagement with the local community, enrolment, and continuity of care.

Other factors often allied to socioeconomic issues but also with specific community social mores are the challenges for indigenous groups, minority groups, and immigrants. Identifying these higher risk groups is an important first step towards implementing strategies that are tailored and effective to the needs of the specific subpopulations.

Issues at the local community and family levels are multiple. The literature suggests that family health beliefs may at times be associated with lower immunisation coverage, but can frequently be driven by poor relationships or lack of effective contact with healthcare service design, and in reverse good relationships with healthcare providers and accessible services can mitigate the effects of family health beliefs. The importance of a trusting relationship with the provider appears to be a major feature in supporting effective healthcare-seeking behaviour.

Effective systems need to be able to identify who is missing out and communicate in a timely fashion with families with reminders in whatever communication form/s are likely to be most effective to that community. Specific groups can be identified to be at higher risk of lower immunisation uptake; in particular preterm infants, children who have acute or chronic illness, children of younger mothers, and, for low income countries in particular, children from parents with lower education levels, more children and short birth spacing, and in some environments female children. These characteristics are likely to vary with communities which highlight the importance of local data to identify the groups that are likely to be at higher risk of missing out on immunisation.

Families do not act in isolation and there are recognisable factors within communities that tend to act with similar characteristics. The most obvious is geographical or religious/belief communities with high numbers of immunisation decliners. However, this can also apply to communities where confidence in the healthcare system may in general be low and are therefore more likely to be open to fears and concerns over vaccine myths and social media inaccuracies.

Maintenance of confidence in vaccines and immunisation programmes for communities and countries is an important part of the mix. Public confidence centres around maintaining trust, both at an individual level of families and healthcare providers, and at the level of the institutions and government.

It is clear that despite all the barriers at the family and community levels, effective healthcare systems with high functioning providers can mitigate the challenges from the environmental and social issues. The provision of sufficient providers needs to be considered. The knowledge and attitudes of the provider are an important part of this, with the provider attitudes and confidence probably being a more important factor than their overall knowledge level. However, provider knowledge is also important in order to maintain their own confidence and particularly not to miss opportunities to offer vaccination via misunderstanding contraindications.

The most important drivers of all are likely to be the higher level organisational factors in the healthcare system – a mixture of leadership, effective and adequate resourcing, political management, community engagement and maintaining agency credibility. At the level of the vaccination provider a well working system drives high immunisation coverage. Key aspects of this include effective population enrolment, supply and costs, record keeping, tracking and continuity of care. Factors that particularly impact on the functioning of systems are provider loss of confidence in its effectiveness, as is seen when data or records are not felt to be available or accurate, resourcing constraints, challenges with multiple providers, and poor data sharing. It is important to be aware there can be gaps between perceptions and the functioning realities with the systems.

Underpinning all of this is the importance of data collection, analysis, and effective use. There is a need to know the population being served so those being missed out can be identified and offered appropriate services both at an individual and at a collective level. The greatest challenge for many immunisation delivery systems is the ability to know the population, offer effective continuity of care from antenatal to postnatal including effective services, record keeping, and family prompts.

Overall, getting the delivery of effective immunisation services right for the community is a *dynamic process of interaction between communities and the healthcare system* (80).

3.4.4 Results and discussion: Interventions to improve the uptake of immunisation services

There were 39 articles that addressed the topic of interventions to improve the uptake of immunisation services in infants and children. These articles were further divided by grouping into major themes listed below. Historic articles were not included in the themes but were used in discussions where appropriate. An historic systematic review from 2000 identified three general areas for interventions designed to improve the update of childhood vaccinations - increasing community demand, enhancing access to vaccination services and using system and provider-based interventions (144). These areas were used to divide this area into four subthemes:

- Interventions that raise community demand.
- Interventions that enhance access to vaccination services.
- Interventions that use system and provider based approaches to improve services.
- Multicomponent intervention studies.

3.4.4.1 Interventions to improve the uptake of immunisation services

3.4.4.1.1 Results

In this category there were 4 identified articles related to the subtheme of social communication; 2 articles related to community and parental education; 4 articles related to parent or family incentives; and 2 articles on client-held records. This gave a total of 12 articles. Results are listed in Table 3.8.

Table 3.8: International studies since 2007 focusing on intervention studies that raise community demand to recommendations obtain high immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Social communication						
Oya-Ita 2011 (145)	Low and middle income countries	Cochrane systematic review	Six studies included. Measurement DTP3 coverage in infants	To evaluate the effectiveness of intervention strategies for improving immunisation coverage in child hood programmes	Facility-based education RR of improving coverage 1.18; combination facility-based education and immunisation record cards RR 1.36; evidence-based discussion RR 2.17; information campaigns RR 1.43	Weak evidence for facility based health education and redesigned record cards to improve coverage; moderate evidence for evidence-base discussions and information campaigns
Oliphant 2010 (146)	Six sub-Saharan African countries	Observational study using surveys and administration records	Children < 5 yrs fully immunised with first measles dose after child health days	To estimate the effectiveness of child health days on health systems coverage	Measles immunisation coverage improvements of average 10%	Activities in child health days can effectively improve measles immunisation coverage
Waisbord 2010 (147)	Afghanistan, India, Pakistan and Nigeria	Summary of literature	Children < 5 yrs	To evaluate the effect of effective communication on polio immunisation coverage	With use of effective communication 12-20% increase in absolute coverage levels and 33-100% increase in relative.	Challenges to polio eradication – poor service delivery leads to poor communication – advocacy, social mobilization and programme communication
Weiss 2013 (148)	India	Observational: Secondary data analysis of routine monitoring information	Children < 5 yrs fully immunised	To explore social mobilization activities in supplemental immunisation activities (SIAs)	Mosque announcements and education in schools increase coverage in mass campaigns by up to 9%	Social mobilisation activities can improve mass immunisation campaigns
Community/parent education						
Kaufman 2013 (149)		Cochrane systematic review	Seven studies, 6 RCT, one cluster RCT	To assess the effects of face to face interventions for informing/educating parents about childhood vaccination on immunisation uptake and parental knowledge	No significant change in immunisation coverage with interventions	Face to face interventions to inform/educate have little or no impact on immunisation status

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Owais 2011 (149,150)	Pakistan	RCT	367 mother-infant pairs, infants ≤6wks, one to one randomisation	To assess the effect of a simple low literacy immunisation promotional educational intervention	Adj. RR 1.39 (39% overall improvement) of receiving all 3 primary doses	A simple educational intervention is effective in low-literacy populations for improving completion of the primary course
Parent/family incentives						
Banerjee 2010 (151)	India	Clustered randomised controlled study	1640 children aged 1- 3 year	To assess a non-financial incentive (food and plate) and reliable service on immunisation uptake	Full immunisation 39% intervention, 18% reliable immunisation, 6% control	Improving reliability of services gives small improvements, but small incentives give larger positive improvements in immunisation uptake.
Chandir 2010 (152)	Pakistan	Longitudinal intervention	Infants up to 18 w of age of mothers receiving food/medicine intervention	To study the effect of a food/medicine coupon on immunisation update	DTP3 increased by RR 2.2 cf to other services with no intervention	Food/medicine coupons can improve immunisation uptake in a low income country
Lewin 2008 (153)	International, low and middle-income countries	Cochrane systematic review	20 reviews	To summarise the evidence of the effects of health system arrangements and implementation strategies for PHC quality.	N/A	Financial incentives can work, but can have undesirable outcomes; task shifting to lay providers can improve HR shortfalls, quality strategies modest impacts
Lucas 2008 (154)	International	Systematic review	Nine trials 25,000 participants	To assess the effectiveness of direct financial provision to economically disadvantaged families in improving childhood wellbeing and education outcomes	None noticed	No evidence of effect of providing extra financial support

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Client-held records						
Osaki 2009 (155)	Indonesia	Observational study on survey data, 3 time points	Parents of children 12 – 23 months	To evaluate the effectiveness of home-based immunisation records	70.9% of children with records were fully immunised cf to 42.9% without	Having family home-based immunisation records increases the likelihood of being fully immunised
Oya-Ita 2011 (145)	Low and middle income courtiers	Cochrane systematic review	Six studies included. Measurement DTP3 coverage in infants	To evaluate the effectiveness of intervention strategies for improving immunisation coverage in child hood programmes	Facility-based education RR of improving coverage 1.18; combination facility-based education and immunisation record cards RR 1.36; evidence-based discussion RR 2.17; information campaigns RR 1.43	Weak evidence for facility based health education and redesigned record cards to improve coverage; moderate evidence for evidence-base discussions and information campaigns

3.4.4.1.2 Discussion

Social communication

A 2008 Cochrane review of community campaign interventions to improve coverage for children in low and middle income countries reviewed six studies, although four were considered to be at high risk of bias (145). The review concluded there was moderate quality evidence that information campaigns increase the uptake of at least one vaccination event (Risk Ratio of 1.43, 95% CI 1.01- 2.02). Child health days in low-income countries focused specifically on improving measles vaccination updates have increased coverage by around 10% overall as reported by Oliphant et al summarising data from population based surveys and local government sources in six sub-Saharan African countries (146).

Social mobilisation activities are important components of improving immunisation coverage for mass vaccination campaigns, such as with measles and polio supplemental immunisation activity (SIA) campaigns. An Indian review on SIAs and social mobilisation campaigns concluded that the quality of the activities is more important than the quantity and measures of quality are currently lacking (148).

The effectiveness of communication as a component in obtaining high immunisation coverage was highlighted in a 2010 article reviewing data for childhood immunisation programmes and summarised from Afghanistan, India, Pakistan and Nigeria (147). The authors concluded that effective social communication has an important impact on improving immunisation coverage. Social communication was defined as advocacy, social mobilization, and better programme communication, including interpersonal communication and behavioural change activities. The summary data showed an overall immunisation coverage increase of 12- 20% in the absolute levels of coverage and 33% to 100% increase in relative coverage compared to baselines when communication was included as a key component of any programme.

I. Community/parent education

The historic 2000 systematic review of interventions to improve childhood immunisation coverage identified six studies on the topic of community-wide education; only one study qualified for review and it was still considered limited in design and conduct (144). The educational messages were delivered via a range of methods including mail, radio, newspapers, television, and posters. There was no evidence that community wide education alone is an effective intervention, but is likely to have its place as a component part of a wider intervention. In low literacy settings, simple direct education interventions appear to play a role (150).

The effectiveness of parent education sessions using face-to-face methods to educate and inform parents about childhood immunisation was assessed in a 2013 Cochrane review (149). Seven studies were reviewed which included 2978 participants in a mixture of single or multi-session education sessions to individuals or groups of parents or antenatal populations. Overall, the findings showed that these strategies did not consistently improve immunisation rates or parental knowledge and understanding of vaccines. However, the authors considered overall the evidence was low to very low quality. One study did an economic analysis of the cost of fully immunising an additional child and concluded it was eight times the cost of usual care, but once again the quality of the evidence was considered low. The review conclusion was that the evidence appeared to show limited effect of such interventions and recommended that it was more feasible and appropriate to incorporate communication about childhood immunisation into healthcare encounters rather than as a separate activity.

II. Parent/family incentives

The 2000 systematic review identified three historic studies on this topic (144). One group-randomised trial was conducted in a US public health centre for the families of 1,133 under-immunised preschool children (156). A lottery for cash prizes of US$25 to US$100 together with posted client reminders was offered as an intervention. They showed a change in delivery of 18% for at least one antigen for the study period. A US retrospective cohort study gave $10 gift certificates to parents on completing child vaccinations in conjunction with a multicomponent strategy that included provider and parent reminders, home visiting, transport assistance and provider education (157). This study showed non-significant gains in immunisation coverage.

From the more recent literature, a 2007 publication undertook a review in high-income countries of studies that offered direct extra financial provision to socially or economically disadvantaged families to improve their overall health, well-being and educational attainment (154). The study identified nine trials with over 25,000 participants. Overall, results did not show any significant gains in the intervention groups for any measure of child wellbeing (including immunisation coverage.

A 2008 Cochrane summary of 20 systematic reviews of the effects of health system arrangements in improving primary health care concluded that financial incentives can be used to influence patient (and provider) behaviour, but can also have undesirable side effects (153).

When studying incentive approaches in low-income countries, a study in rural Rajasthan, India undertook a clustered randomised controlled study with 134 villages randomised into three groups: control, a monthly reliable immunisation clinic, and the monthly immunisation clinic with a small food incentive (raw lentils with a metal plate)(151). Surveys undertaken in randomised households 18 months after the interventions were implemented showed full immunisation for children aged 1 to 3 years was 6% for the control group, 18% for the group having regular clinics, and 39% for the group having regular clinics with also a small food incentive. The authors comment on the importance of improving reliability of services, but also the large extra positive effects in resource-poor areas of small incentives. A similar outcome was seen in a Pakistani intervention in a low socioeconomic region which offered food and medicine vouchers to mothers of infants to encourage timely completion of the first three DTP vaccination events (152). The intervention increased immunisation coverage at 18 weeks of age by a factor of two (RR 2.0, 95% CI 1.95-2.48).

III. Client-held immunisation records

The historic 2000 systematic review identified eight studies on this topic, four of which were eligible for review (144). Overall, these studies reported improvement in coverage from 5 to 15%, with some, but not all, reaching statistical significance. The review concluded that there was insufficient evidence to assess the effectiveness of this strategy.

The 2008 Cochrane review of interventions to improve immunisation coverage for children in low and middle income countries did highlight the importance of improving or redesigning immunisation record cards as part of a multicomponent strategy that is likely to improve immunisation coverage (145). An Indonesian study reported that in 2002/3 period for children aged 12 to 23 months, those who did not have home-based immunisation records had overall 27.1% lower immunisation coverage than those who did have records(155). Since this time, Indonesia has implemented a national ministerial decree to state that the Maternal and Child Health Handbook is to be the only home-based record of maternal, new-born, and child health records and they have since seen a significant increase in ownership and use of records.

3.4.4.2 Interventions designed to enhance access to vaccination services

3.4.4.2.1 Results

There were 2 articles identified in this category. Results are summarised in Table 3.9.

Table 3.9: International studies since 2007 focusing on intervention studies that enhance access to vaccination services to obtain high immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Hambidge 2009 (158)	USA	Randomised controlled trial	811 infants to 15 months, urban hospital	To test a stepped intervention of reminder/recall/case management to increase Well Child visits and immunisation rates	Intervention infants fewer days without immunisation coverage (109 vs 192 days).	A stepped intervention study can improve immunisation coverage
Kolasa 2010 (159)	USA	Observational intervention study	610 children not up to date at 10 months, large US city	To examine the impact of provider chart audits and parental outreach services to improve coverage	Provider chart audits improved data completeness by 64%.	Audits improve immunisation records. Outreach services are effective for timeliness but no evidence for reducing overall coverage outcomes

3.4.4.2.2 Discussion

The importance of reducing costs to the client was well highlighted historically in the 2000 systematic review which identified 26 studies on this topic (144). Of these, 19 were included in the review and 7 of these used this as a single intervention. From the single intervention studies, there was an improvement in coverage with a median change of 10% improvement (with a range from -15% to 29%). One economic analysis estimated an adjusted cost-effectiveness ratio of this intervention at US$43 per additional vaccination. The review concluded that out-of-pocket costs for vaccinations are effective in improving coverage.

This review also identified the effectiveness of expanding access to healthcare (144). It identified 25 studies on this topic and 16 qualified for review. Types of expanded access included drop-in clinics, increased hours on nights and weekends, providing vaccinations in emergency departments, dedicated clinics, special vaccination appointments, vaccination of in-patients, and transport assistance. Overall there was a median percentage point improvement in coverage of 10% (with a range of -8% to 35%). There was one economic evaluation that gave an adjusted estimate of average programme costs based on that study at US$7.65 per vaccination delivered. The review concluded that there was strong evidence that expanding access to services as part of multicomponent services was effective, but there was insufficient evidence to assess the intervention by itself.

In the US setting there are vaccination-promoting strategies set for low-income target populations in nonmedical settings, called Women, Infant and Children settings (WIC). The WIC is the largest point of access to health-related services in the US for low-income pre-schoolers and services over 45% of the US birth cohort, involving food vouchers, and a range of health status evaluations. This review identified 10 historic studies in this setting, which used a mixture of interventions, including education, assessment, referral free vaccinations, and transportation assistance (144). Overall, these studies showed immunisation coverage improvement of 4% to 34%. Two economic evaluations of these interventions gave adjusted cost-effective ratios from $34 to $84 for each fully vaccinated child. The review concluded that there was sufficient evidence to show that interventions in these settings are effective in improving immunisation coverage.

Interventions in child-care centres involve efforts to encourage immunisation for children younger than five years of age. This includes assessment of the child's immunisation status at entry, and/or on various time points, education or notification for parents, and possibly on site vaccination services. The 2000 systematic review only identified one study in this area and it was not adequate for review so was unable to make any conclusive statement on the effectiveness of these interventions. This review also identified 10 studies on the topic of vaccination policy requirements for school or childcare attendance, of which 9 were considered eligible for review (144). Three studies, all from North America, looked at outcomes and found a median change of 15% improvement in coverage with a range of 5% to 35%. The review concludes that there is sufficient evidence that vaccination requirements for child care and school are effective in improving coverage rates.

The historic systematic review identified 15 studies on the topic of home visiting to immunise, of which 7 were eligible for inclusion (144). When evaluating multicomponent strategies that included home visiting, there were changes in coverage ranging from 2% to 20% with a median of 13% improvement. Two studies with home visiting alone as an intervention found changes in coverage of -1% to 10%. Four economic evaluations showed adjusted cost-effectiveness ratios ranging from US$513 to US$13,020 per additional vaccination. The review concluded that home visiting interventions are effective in improving immunisation coverage. However, they can be highly resource-intensive relative to other available options for improving vaccination coverage. More recent literature has reviewed home visiting as a strategy and concluded that home visits are likely to be more cost-effective when used as part of a multicomponent intervention. Refer below (158,159).

Hambridge et al (150) in the USA used a USA stepped intervention programme in which home visits are utilised for children who have still missed immunisation events despite earlier, less costly, and less intense interventions; and Kolsa et al (149) in another USA intervention study used home visiting following a provider chart audit and parental recall when children were still unimmunised.

3.4.4.3 System and Provider-based interventions to improve the uptake of immunisation

3.4.4.3.1 Results

In this category there was one overview systematic review article covering the whole theme; 6 articles focused on measuring and monitoring approaches; one article on provider recall/reminder systems; 2 articles on provider incentives, 2 on provider roles; 2 on provider education; 3 articles on supervision/support to providers and 3 articles on clinic-based interventions. In total there were 20 identified articles in this category. Results are presented in Table 3.10.

Table 3.10: International studies since 2007 focusing on intervention studies that use system and provider based interventions to obtain high immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Lewin 2008 (153)	International, low and middle-income countries	Cochrane systematic review	20 reviews	To summarise the evidence of the effects of health system arrangements and implementation strategies for PHC quality.	N/A	Financial incentives can work but can have undesirable outcomes. Task shifting to lay providers can improve HR shortfalls, quality strategies modest impacts on PHC quality
Measuring and monitoring						
Bosch-Capblanch 2009 (62)	Low income countries	Randomised observational study of use of a performance measurement intervention	41 countries, 1082 primary healthcare units in 188 randomly selected districts	To measure the accuracy and quality of immunisation information systems in GAVI eligible countries.	50% countries had verification factor (VF) of accuracy less than 80%, nine consistently high VF	The data quality audit tool is an effective diagnostic tool to identify performance issues in immunisation systems
Ivers 2012 (160)	International	Cochrane systematic review	149 studies, of audit and feedback interventions	To assess the effects of audit and feedback on healthcare professional and patient outcomes	Variable	Feedback may be more effective when baseline performance is low; the feedback is from a colleague or supervisor, provider more than once, in writing and verbally, includes clear targets and action plan
Kolasa 2010 (159)	USA	Observational intervention study	610 children not up to date at 10 months, large US city	To examine the impact of provider chart audits and parental outreach services to improve coverage	Provider chart audits improved data completeness by 64%.	Audits improve immunisation records. Outreach services are effective for timeliness but no evidence for reducing overall coverage outcomes
Schauer 2009 (161)	USA	Observational study of an intervention	All children 24 years of age in one district	To measure the progress towards an effective immunisation information system	Increased measurement of immunisation completeness rates for 58% to 64%	A district-wide register can effectively measure achievements for population-base objectives
Stein-Zamir 2010 (127)	Israel	Review article	Nationally all children 2 years of age	To report on the effectiveness of the use of an NIR	National coverage at 2 yrs of age 93% DTP-IPV, 94% MMR1.	The implementation of a comprehensive national register enables effective immunisation coverage, reporting and monitoring

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Tatineni 2009 (162)	India	Observational study of an intervention	698 children 12 – 23 months in one district	To measure the effectiveness of a multicomponent intervention (REACH) that electronically records information and enables tracking	98% complete immunisation cf to 43% in those outside the intervention district	Information technology combined with action orientated use of the data can result in significant improvements in immunisation coverage
Provider recall/reminder systems						
Ahlers-Schmidt 2012 (112)	USA	Randomised controlled trial	90 mothers of new-born infants born in one urban hospital	To pilot the effectiveness of a text reminder for completing immunisation events	No statistical difference in immunisation coverage at 2, 4, and 6 months of age.	Text messaging appears well accepted, numbers too small to know if it is effective in improving immunisation timeliness or coverage
Provider incentives						
Lewin 2008 (153)	International, low and middle-income countries	Cochrane systematic review	20 reviews	To summarise the evidence of the effects of health system arrangements and implementation strategies for PHCquality.	N/A	Financial incentives can work but can have undesirable outcomes. Task shifting to lay providers can improve HR shortfalls, quality strategies modest impacts on PHC quality
Witter 2012 (163)	International, low and middle-income countries	Cochrane systematic review	9 reviews	To review the effect of paying for performance to improve the delivery of healthcare in low and middle-income countries	N/A	Generally poor quality evidence and variable outcomes. Unable to draw conclusions
Provider roles						
Lewin 2008 (153,164)	International, low and middle-income countries	Cochrane systematic review	20 reviews	To summarise the evidence of the effects of health system arrangements and implementation strategies for PHC quality.	N/A	Financial incentives can work but can have undesirable outcomes. Task shifting to lay providers can improve HR shortfalls, quality strategies modest impacts on PHC quality
Patel 2010 (164)	India	Review article	57 articles	To summarise the evidence for the role of community health workers in improving immunisation coverage in rural India	No measurements	Limited quality of studies. CHWs make diverse contributions, but overall are likely to improve immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Provider education						
Giguere 2012 (165)	International	Cochrane systematic review	45 studies, 14 RCTS and 31 interrupted time series	To assess the effect of printed educational materials on the practice of healthcare professionals and patient health outcomes	Median absolute difference in practice outcomes 0.2	The use of printed educational materials may slightly improve health care professional practice, but no clear established outcomes on patient outcomes.
Uskun 2008 (166)	Turkey	Intervention experimental pre-test post-test design	229 HCWs in PHC centres	To evaluate the effectiveness of an intervention to increase PHC worker knowledge on immunisation coverage.	Significant increase in knowledge and childhood immunisation coverage (p< 0.001)	Intensive training improves HCW knowledge and immunisation coverage Important factors include performance of trainers, gender, profession, content of training
Supervision/support to providers						
Babu 2011 (167)	India	Intervention study, pre-post design	Intervention strategy across all services in a district. Outcomes coverage estimates children 0 – 2yrs	To evaluate the effectiveness of a package of supportive supervision to improve immunisation coverage rates	DTP3 coverage 25% prior to intervention, 84% after, measles 15% prior and 81% post.	Supportive supervision appears effective – utilising clear job descriptions, mentoring, assessments, diaries and reporting, training, and 'handholding'
Boom 2010 (168)	USA	Intervention study, pre-post design	83 Paediatric and family medicine practices in a large urban centre	Evaluating the effectiveness of academic detailing as an intervention to improve immunisation coverage levels	Immunisation rates for children 12 – 23 months increased by 1% post the intervention	Office-based interventions are not sufficient alone to significantly increase immunisation coverage
Djibuti 2009 (169)	Georgia	Control study of a district intervention, pre-post design	15 intervention districts, 15 control districts	To evaluate the effectiveness of a multicomponent intervention using supportive supervision	Significantly less vaccine wastage and higher DTP3 rates	Provider-based interventions can be effective in improving immunisation programme functioning

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Clinic-based interventions						
Ali 2009 (170)	Australia	Intervention study, over one year time period	24 General Practices in Central Sydney with < 90% coverage rates for children < 2 yrs	To assess the effectiveness of practice-visiting to give guidance and support	% practices with coverage >90% increased from 30.4% to 68.2%.	Most common barriers to immunisation coverage were reporting issues. Regular support visits helpful. Other identified barriers; management support, knowledge transfer and staff turnover, streamlining processed
Hambidge 2009 (158)	USA	Randomised controlled trial	811 infants to 15 months, urban hospital	To test a stepped intervention of reminder/recall/case management to increase Well Child visits and immunisation rates	Intervention infants fewer days without immunisation coverage (109 vs 192 days).	A stepped intervention study can improve immunisation coverage.
Roberts 2011 (126)	USA	Observational study	Six Paediatric practices in one area	To identify key components in quality improvement at the practice level for immunisation delivery	Not measured	Quality improvements that may be effective include improving the accuracy and location of records and provider prompting.

3.4.4.3.2 Discussion

Historic studies have shown the importance of provider-base interventions, particularly focused on effective measuring and monitoring. This was seen with a US study using a national measurement tool (the Clinic Assessment Software Application from the CDC) in a practice: comparing it with a chart review showed there was a significant underestimation in coverage using this tool which appeared to be due to over stringent inclusion criterion, different dosages for different vaccine brands, and the wide range of acceptable ages (171). The authors commented that different methods of calculation may cause as much as 20% difference in immunisation rates for the same population groups, which may then lead to vastly different responses and interventions. Alongside, measuring the importance of assessment and feedback has been well demonstrated. Provider-assessment and feedback involves retrospective evaluation of provider performance in delivering national schedule vaccines to a population. It can also involve activities such as incentives or benchmarking, where performance is compared to a goal or standard. The 2000 systematic review identified 27 studies, of which 14 qualified for review, most of which were part of multicomponent studies (144). They commented that the assessment and feedback components were not well described in detail. One study found that assessment and feedback to individual physicians may be more effective than feedback to the chief or service, but there may have been alternative explanations for this finding. Overall, the studies demonstrated increases in immunisation coverage from 15 to 43% with a median of 16% improvement. Using assessment and feedback as part of a multicomponent strategy gave improvements of 1% to 43% coverage with a median of 17%. The review concluded that there was strong evidence that assessment and feedback of vaccination coverage information to providers was effective in improving coverage.

The 2008 Cochrane analysis of 20 review articles that looked at interventions to improve the delivery of cost-effective interventions at the primary care level in low and middle income countries reached conclusions around the type of programmes used (153). They noted that multiple vertical programmes can lead to duplication of services, fragmentation and inefficiencies. However they concluded that interventions to improve integration of services have not been evaluated adequately.

I. Measuring and monitoring

An important aspect of improving coverage is the ability to measure for monitoring purposes. The WHO has created an audit tool called the Data Quality Audit (DQA) for low income countries to be able to compare data collected from health service records of immunisations administered with reports of immunisations at the central level and to also collect quality indicators of the reporting system. The DQA was reviewed in 41 countries and 1082 primary healthcare centres in randomly selected districts (66). Overall results showed that nearly half of the countries have significant challenges with accuracy of data and the DQA was able to identify data quality challenges at all levels of their services. DQA also identified good performance which can be used as a useful feedback tool.

The effectiveness of measuring and responding to data was shown in an Indian intervention study in 2007. Responding to the challenge of low immunisation coverage and poor information, an intervention was implemented for 698 children aged 12 to 23 months in rural Andhra Pradesh, with the implementation of the Rural Effective Affordable Comprehensive Healthcare (REACH) project, which involved recording individual children's immunisation status, tracking, and offering immunisation (162). This simple recording and tracking intervention resulted in improving immunisation coverage rates from 43% to 96%.

Focusing on higher income countries, the Wisconsin Immunisation Registry in the US was introduced with the aim of measuring achievements of population-based objectives to gain high immunisation coverage (161). By the end of 2008 across Wisconsin, there was a rise in fully immunised at two years of age from 61(86%) of the counties and completion rates increased overall from 58% to 64%. This study reports that an immunisation register can be a *powerful tool* to measure coverage among local populations, assess improvement towards contract objectives and target resources towards pockets of need. A similar strategy in Israel has seen the launch of an NIR in 2008. A 2010 review reports on progress towards a comprehensive national register and reports the importance of this in a national strategy to monitor and respond to immunisation coverage in Israel (127).

A USA study delivered an intervention comprising provider chart audit followed by telephone, postcards and home visits (159). They focused on 5610 children not up to date at 10 months of age living in urban Philadelphia. Following a provider chart audit, 64% of those originally identified were actually found to be up-to-date. Half of the remaining children not up to date were reached with the outreach intervention by 13 months of age; however, it was noteworthy that most of these children were again not up to date by 19 months of age. A 2010 Cochrane publication identified 140 studies where the primary focus was on audit and feedback to improve health professional practice or patient outcome (160). Of these 82 comparisons from 49 studies were identified and analysed. Overall findings showed a significant gain in desired outcomes with the weighted median adjusted risk difference (RD) of 4.3% (95% CI 0.5 – 16%) for an increase in healthcare provider behaviour change. Multivariable regression analysis indicated that the most effective feedback occurs when the baseline performance is low to start with, the source is from a supervisor or colleague, the intervention is provided more than once, delivered in verbal and written formats and includes targets and an action plan.

II. Provider recall/reminder systems

Historically, recall and reminder systems have consistently been shown to be effective in improving immunisation coverage. The 2000 systematic review identified 60 studies, of which 42 qualified for review on this topic (144). They estimated a median percentage point gain in immunisation coverage of 16% with a range of -8% to 47%. They found there was strong scientific evidence for the effectiveness of reminder and recall in improving immunisation coverage. A further 11 studies were reviewed that focused specifically on the economic evaluation of reminder/recall interventions. The adjusted cost-effectiveness ratios for single component interventions range from US$3 per additional vaccination to US$46 per vaccination, with a median of US$9. The review concluded that there was strong evidence that provider reminder/recall interventions are effective in improving coverage.

A US study piloted a text reminder intervention with the aim to improve the uptake of immunisation at the 2, 4 and 6 month visits (172). There were 90 participants were divided randomly into either the intervention which was a text message reminding the parent prior to the immunisation due date or the control group. The results suggested greater numbers of intervention children received their due immunisation events on time, but the study was underpowered to be statistically significant. The authors also reported problems around managing the technical side of text messaging and telephone usage. There was strong parental support for the initiative with 88% reporting text messaging very helpful and 17% somewhat helpful.

III. Provider incentives

The 2008 Cochrane review of 20 studies that focused on the effects of health system arrangements in improving primary health care concluded that financial incentives can be used to influence provider (and patient) behaviour, but can also have undesirable side effects (153). A further Cochrane study published in 2013, reviewed pay-for-performance approaches to delivering health interventions in low and middle income countries (173). Pay-for-performance is defined as where financial or other rewards are given to patients, providers or healthcare systems. Overall, nine studies were reviewed and the conclusions were that the quality of the evidence was generally very poor, and the outcomes varied considerably with a wider range of settings, so no generalisable conclusions could be drawn.

IV. Provider roles

Standing orders are interventions where non-physicians can prescribe and/or deliver vaccines to populations by protocols without direct physician involvement at the time of the delivery of the event. The historic systematic review of 2000 identified 16 studies, or which 11 qualified for a review (144). Of these, six evaluated standing orders alone and five were multicomponent interventions. Standing orders were found to improve vaccination coverage in adults. A single study showed ‘modest’ declines in missed opportunities to vaccinate for children. The review concluded that there was insufficient evidence to assess the effectiveness of standing orders to improve vaccination coverage in children.

More recently, the 2008 Cochrane review looking at interventions that can strengthen health systems concluded that task-shifting between healthcare providers, such as from doctor to nurse and from health care professionals to lay providers, may offer opportunities for addressing human resource challenges and expanding primary healthcare (153).

In the context of low income countries, India has focused on a national strategy on moving resources to creating more Community Health Workers (CHWs), particularly to assist immunisation programmes in rural regions. While the number and quality of available studies makes it difficult to assess effectiveness, one review article comments that CHWs make diverse contributions towards strengthening immunisation programmes in India and should be considered as an important component part of strategies (164).

V. Provider education

The historic systematic review identified six studies on this topic, of which four qualified for the review (144). The authors concluded that there was insufficient evidence to assess the effectiveness of education-only interventions because of the small number of studies and design limitations. A 2001 published Cochrane review looked at interventions for improving coverage of immunisation in children 0 to 4 years in low and middle income countries (145). The authors reviewed six studies, of which four were considered to be at high risk of bias. They concluded that facility-based health education may improve the uptake of the infant vaccines coverage with a Risk Ratio of 1.18 (95% CI 1.05-1.33). However, a stronger effect with improving immunisation coverage is seen with a combination approach that also includes redesigned immunisation record cards giving a RR of 1.43 (95% CI 1.01 to 2.02).

More recent literature has demonstrated the effectiveness of good provider training. This was shown in an intervention study in Turkey undertaken in 2004, which undertook intensive training of 229 primary healthcare workers with eighteen workshops over a period of around a year (166). The intervention significantly increased knowledge ($p<0.01$) and also increased vaccination coverage for all childhood vaccines ($p < 0.001$). A Cochrane review of the benefits of printed education material for healthcare professionals for improving professional practice patient health outcomes reviewed 44 studies and concluded that professional education material slightly improved professional practice (standardised median change in level = 1.69) (165). They were unable to ascertain which characteristic particularly influenced their effectiveness.

VI. Supervision/support to providers

Focusing on improving support and mentoring to providers was shown to be effective in an intervention study in the Karnataka state of India (167). This region was purposely chosen as an area with low immunisation coverage and poor service implementation. The intervention chose a range of activities including clear job descriptions, mentoring, assessing work performance, diaries and reporting, training and support, which was delivered through supportive supervision to primary healthcare providers. The results showed significant improvements in immunisation coverage for all three primary events groups ($P<0.001$). This intervention was directed at a catch up campaign and coverage appeared to increase from 28% for the BCG, 25% from the DTP3 dose and 15 % for the measles 9 month event to 100% for all three measures in the seven participating areas.

Supportive supervision is defined as a one-on-one process to focus on the identification and resolution of problems, promote quality and improve standards, teamwork and better communication in teams. A study from Georgia designed a multicomponent intervention to improve childhood immunisation rates (169). A component of this was supportive supervision for immunisation programme managers and healthcare providers and compared 15 interventions to 15 control districts. The authors were unable to qualify the gain from supportive supervision, but concluded that supportive supervision does have independent positive effects on immunisation programme uptake.

A US intervention study in metropolitan Houston focused on using peer academic detailing (168). The authors defined academic detailing as a form of continuing medical education (CME) in which a health educator visits a health professional and the clinic staff in their office setting to provide a brief education intervention on designated topics. This study recruited ultimately 189 practices from an original database of 852, randomly allocated to intervention or control and used an education team of a doctor, a nurse, and an office manager to deliver 83 peer education sessions. At baseline 59% of control and 59% of intervention practices met the up-to-date criteria for immunisation coverage for children at 12 to 23 months of age. At one year post intervention, there was a 1% improvement in coverage for the intervention group and a 3% reduction in coverage for the control group. The improvement was minimal and the authors recommended that future interventions should incorporate multiple visits and include motivational approaches utilising baseline coverage data and incorporate them into a multicomponent approach.

VII. Clinic-based interventions

An Australian study focused on a locality in central Sydney that had lower immunisation coverage rates for the childhood programme than the national average (170). They selected practices with less than 90% of children fully immunised at the age of two years. They undertook an intervention that involved semi structured interviews with all the key practice staff. A qualitative analysis of the results identified a range of modifiable practice systematic issues. There was no report on whether this intervention improved outcomes.

A US quality intervention published in 2011, using quality improvement principles, was undertaken in a convenience sample of six paediatric practices that were part of the South Carolina Paediatric Practice Network (174). Initial surveys were undertaken with the practices with questions around immunisation assessment, record keeping, missed opportunities, and prompting. Following this research, staff visited to directly observe processes and review patient charts. Four of the six practices reported that they prompted the needed immunisation at sick visits, but on observation, only one practice did. There was considerable variation within practices, multiple forms and poor recording of immunisation events making it difficult to determine immunisation status for individual children. The authors concluded that survey responses do not always reflect actual practice and direct observation was a useful part of developing effective quality interventions.

A nice example of a tracking and case management intervention was undertaken with a US study undertaking what they called a ‘stepped intervention study’ which was a randomized controlled clinical trial involving 811 infants born in an urban hospital in Denver and followed through till 15 months of age (158) The intervention involved three steps. The first step was that all infants were given language-appropriate reminder postcards for every Well Child visit. Step two was that infants who missed an appointment had telephone reminders plus postcard and telephone recall, and step three,was for infants still behind on their immunisation and Well Child visits after the first two steps and involved intensive case management and home visits. Infants in the intervention arm had fewer days without immunisation coverage in the first 15 months of life (109 versus 192 days, p<0.01), were more likely to have 5 or more Well Child visits and were more likely to be up-to-date with the 12-month immunisations. The cost per child overall was US$23.30 per month.

3.4.4.4 Multicomponent interventions designed to improve the uptake of immunisation services

3.4.4.4.1 Results

There were 5 articles identified in this category. Refer results in Table 3.11.

Table 3.11: International studies since 2007 focusing on intervention studies that use multicomponent interventions to obtain high immunisation coverage

Reference	Country	Type of Research	Participants & settings	Aims	Associations with immunisation coverage	Key Findings
Findley 2008 (175)	USA	Retrospective observational intervention study,	Urban Latino community, children up to 2 years of age	To assess the effectiveness of a comprehensive, coalition-led community-based immunisation programme.	Children enrolled 53% more likely to be up to date cf to those in non-intervention	A multicomponent intervention that includes provider education, outreach and reminders is effective in improving immunisation coverage.
Igarashi 2010 (176)	Zambia	Time lag Intervention study	Two intervention districts in urban area, 500 caregivers of children 12 – 23 months	To assess the impact of an integrated community-based child health intervention (Growth monitoring Programme Plus) on immunisation coverage rates.	Immunisation coverage increased significantly after the initiation of the intervention p = 0.011	An integrated community based programme that includes more frequent and more comprehensive e primary health care services can improve immunisation coverage
Uddin 2012 (177)	Bangladesh	Intervention study, pre and post design	Children 12 – 23 months in a rural area, 4 sub-districts	To assess the effectiveness of a multicomponent intervention comprising service provider training, a screening tool, social support group for social mobilisation	Significant increase in coverage from baseline to completion of intervention p<0.001	A multicomponent intervention that included provider training, policy and geographical boundary changes, screening checklists, community support groups and modified immunisation sessions can significantly improve immunisation coverage
Uddin 2010 (178)	Bangladesh	Intervention study, pre and post design	Two urban slums, infants 12 – 23 months	To assess the effectiveness of a multicomponent intervention comprising service provider training, a screening tool, social support group for social mobilisation	Baseline immunisation 43%, post intervention 99%	A package of interventions which includes service provider components and social mobilisation can be very effective at improving immunisation coverage

3.4.4.4.2 Discussion

Table 3.11 lists the more recent literature on multicomponent interventions published since 2007 (89,166-168). Multicomponent interventions include education to target populations and sometimes to immunisation providers alongside at least one other activity to improve immunisation coverage. Briss et al, in the historic systematic review in 2000, identified 34 studies of this nature, of which 17 qualified for review (144). Interventions included community or client education, also client reminders, provider education, expanded hours or access in clinical settings, provider reminders, reduction of out-of-pocket costs, client-held records, medical and psychosocial assessments, nutrition services, and home visits. Fifteen of the studies that reported vaccination coverage measures found changes in coverage ranging from -4% to 29% with a median of 21% in follow-up times up to 5 years later. Two studies undertook economic evaluations of multicomponent interventions, including education, and estimated that the average programme costs per child vaccinated was US$23. The data did not allow attribution of the portion of the overall effect to individual components.

An intervention study in Bangladesh, a low income country setting, in 2009 focused on improving coverage in rural hard-to-reach areas (177). They utilised a multicomponent package approach which included higher level policy, provider, service delivery, and community mobilisation. All the interventions included policy changes around geographic areas and provider training and there were two different arms; one used community support groups and extra immunisation clinics while the other arm instigated provider screening checklists. Both interventions were highly effective at increasing coverage for infants of 12 to 23 months from around 50% fully immunised at baseline to nearly 90%. The relative contribution of each intervention was not able to be ascertained. A similar approach was delivered in two urban slum areas in Bangladesh utilizing a similar package of extra clinics, service provider training, a provider screening too,l and community support for social mobilisation (178). This study showed a 33% reduction in drop-outs and increase in vaccination of children, particularly those of working mothers, from initially only 14% immunised to 99%. The authors recommend a package of intervention as the most effective strategy.

The advantage of integrating immunisation programmes with effective other child health approaches was demonstrated in an urban Zambian study, which demonstrated higher immunisation coverage was obtained when implementing an immunisation programme that had been integrated into a community-based child health approach called the Growth Monitoring Programme Plus, the local version of the international Integrated Management of Childhood Illnesses (IMCI) programme (176).

Finally, a multicomponent intervention in a high income country is reported in a US study using a retrospective matching birth cohort design to evaluate a multicomponent intervention focused on improving child vaccination rates in a Latino, low socioeconomic area of New York City (175). The intervention was developed with a partnership of local key stakeholders, including health, education, social services, housing, health insurance, and child and parenting programmes. It consisted of packaging community-appropriate immunisation promotion materials, trained peer health educators, implemented personalised immunisation outreach and promotion services within social service and education programmes, outreach, education, reminder to parents, and supported provider immunisation delivery. Prior to the intervention, the childhood immunisation rates of infants aged 19 – 35 months was around 57%. Between April 1999 and September 2003 10857 births were identified. There was an 11.1% gain in immunisation coverage for the children engaged in the intervention over the control children and an improvement in timeliness of delivery by 11 days overall. Results remained significant three years later. The authors commented that a community-driven comprehensive immunisation – promotion intervention is effective. The identified major attributes of success included community ownership of the programme, integration of the promotional material into the social service and education programmes, training and use of peer educators, intense parental education and empowerment/support, and culturally appropriate reminders designed as a result of the intervention.

3.4.4.5 Interventions designed to improve the uptake of immunisation services: Summary

Just as there are a range of barriers to gaining high immunisation coverage, there is no one single intervention that can be delivered alone to achieve maximum coverage rates. Recognising that this is a complex mixture of social and physical environmental factors, governance and health system factors, any intervention has to work alongside all these factors.

At the community level, interventions that have been shown to be effective that are focused on increasing community demand are community campaigns and use of social media. Campaigns have been shown to be particularly effective in low income countries for one off catch-up programmes. Their role in the maintenance of on-going immunisation programmes is less clear and is probably more about effective on-going community engagement. There is a need to take an effective approach to social communication as an important aspect to maintaining community confidence in an immunisation programme.

Education at the community level has not been shown to be an effective strategy in isolation, but may be effective as part of a wider multicomponent intervention. One-on-one education to parents has also not been shown to be effective and the sensible suggestion by the Kaufman Cochrane review is that this may be more effective incorporated into healthcare encounters.

Client incentives appear to be at times effective and cost efficient, particularly for areas of low immunisation coverage in low income countries. Their effectiveness elsewhere is less clear and at times may produce undesirable effects.

Effective use of client records is an important strategy in low income countries, but probably less relevant to higher income countries where health provider records and recall systems are more adequate and integrated.

Reducing up-front costs to the client and expanding access to services are important and effective interventions, particularly to overcome the barriers for families and communities in poverty. Some US data suggest that vaccination can be effective in non-medical settings for low income families; this has not been shown in other high income countries. Home visiting is an effective strategy, but extremely resource-intensive. It is most cost-effective as part of a multicomponent strategy in a step-wise intervention approach where structural and provider interventions are delivered first, followed by home visiting for those who did not receive immunisation services with the first step interventions.

Interventions at the provider level have the strongest evidence for effectiveness. Important elements include effective service integration both at the vertical and horizontal level, with effective governance, strong programme infrastructure, engaged stakeholders with functional relationships, and effective data collection and usage for planning and decision-making.

The ability to measure and monitor is a core ingredient for an effective programme, for measuring, monitoring, and feedback at the programme level as well as for the ability to know the individual child's records and give timely reminders to the family.

There are many aspects at the provider systems level that make a difference to gaining high immunisation coverage of their population. Audit and feedback have strong evidence for their effectiveness, the most effective when starting from a low baseline. Functioning recalls (precalls) and reminders that work for the community they are being delivered to are highly cost effective. Well delivered support and supervision programmes can be highly effective, probably more so if part of multicomponent approaches. Provider education needs to remain a component in effective programmes, but has little effect alone.

A range of multicomponent interventions have been shown to be effective. These include variable mixes of system changes, including policy change, community empowerment, community and client education, reducing costs to clients, expanding services, improving record keeping, reminders and audits, peer educators, supervisory visits, provider education, and outreach or home visiting. Interventions that integrate with other effective child health programmes and those that use community empowerment utilising community driven models appear effective when well designed.

3.5 Recommendations

Synthesising the findings from the above literature review, there are common themes with respect to factors that can improve immunisation coverage and/or timeliness of delivery. The US Task Force on Community Preventive Services undertook an international review of evidence and reported on the findings in 2000 (128). Their major conclusion was that *improving coverage in impoverished urban communities should be a priority* and the recognition that utilising the knowledge with local approaches is necessary; therefore *applying local experience is important*. They created a list of recommendations based on the strength of the literature (128).

- *Increasing community demand for vaccination through:*
- *Client recall/reminder systems*
- *Multicomponent interventions that include education*
- *Enhancing Access to Vaccination Services through:*
- *Reducing out-of-pocket costs*
- *Expanding access in health care settings*
- *Provider based interventions:*
- *Reminder/Recall systems*
- *Assessment and feedback for providers*
- *Standing Orders*

Recognising immunisation coverage equity gaps within populations as an important part of an effective system needs also to be stressed. Semali et al highlighted the importance of governance and effective health systems to monitor for and respond to equity gaps (78).

A summary article by Diekema in 2012 reviewing the published literature on improving immunisation coverage concluded that firstly, socioeconomic barriers and disincentives to immunisation need to be overcome (110). This includes removing cost and travel barriers to accessing health care and could consider positive financial incentives to encourage update, as has occurred in Australia. Secondly, they recommend school-entry requirements as per the system in the US be strengthened and reinforced, including taking a tighter approach to obtaining of exemptions. Thirdly they recommend focusing on reducing misinformation *promptly and aggressively.* They also suggest, fourthly, giving attention to clinicians to support them in *learning to use the tools of persuasion effectively*. The authors discussed the tension between data and facts and emotional appeals. A core element stressed is the importance of the health care provider (HCP) as the best opportunity to engage with parents and the importance of the trusting relationship in the patient-provider relationship.

A very useful article, based on the experiences of immunisation coverage in the US, updates the recommendations from the US Task Force in 2000 and synthesises the research data to 2011 (129). The authors have created a list of 10 recommendations to improving childhood immunisation services which includes the need for comprehensive and consistent healthcare for all children, adequate financial reimbursement to providers with both direct and indirect costs recognised, effective integration of immunisation registers and records, collaboration between manufacturers and government to ensure secure vaccine supplies, open and transparent systems to maintain provider and community trust, support for ongoing education to providers, increasing communication participation, education and partnership, improving disease and immunisation coverage monitoring, supporting further research for development of new and improved vaccines and delivery mechanisms, and having greater transparency in vaccine research and development.

3.6 Summary of Chapter 3

There are multiple barriers to obtaining and maintaining high immunisation coverage. However, these are identifiable and all modifiable. A range of interventions has been shown to be effective in many areas, but these require coordinated efforts recognising the interconnected parts. Greatest gains are likely to be achieved through improvements in the health care systems, from the top-level governance and policy, through to effective service integration and then to the functionality of the provision of services with engagement of providers. Parent and child characteristics that can create barriers to uptake of immunisation services are important, but can often be mitigated by effective service provision. However, the service provision needs to be supported in a positive social environment to create and maintain the community confidence and hence demand for services.

CHAPTER 4 COMMENTARY ON THE PROGRESS IN INFANT IMMUNISATION COVERAGE AND DISPARITIES IN COVERAGE IN NZ FROM 2000 TO 2012

4.1 Outline of Chapter 4

The aim of this chapter is to present commentary on the progress and the challenges for immunisation coverage in the NZ childhood programme through the period 2000 to 2012. This covers the context of immunisation delivery in these years, the barriers to improvements, and progress over time. These articles summarise my research over this time period, which will be discussed in greater detail in the following chapters.

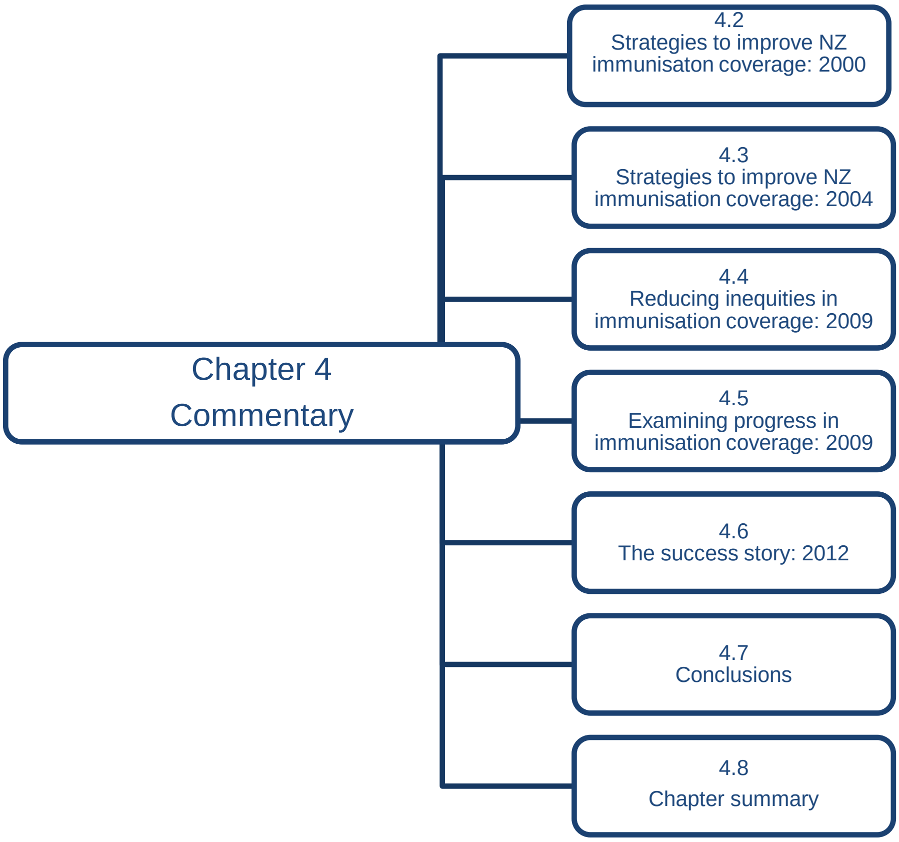

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Figure 4.1: Outline of Chapter 4

4.2 Strategies to improve NZ Immunisation coverage: Commentary 2000

In my role as the Medical Director of IMAC I initially wrote a short report to the MoH in 1999 in response to reports that immunisation coverage rates might have been dropping, outlining the issues and concerns. Refer Chapter 2 Section 2.3. I was then invited to submit a commentary paper on this topic.

My first commentary article regarding the challenges, barriers, and ways forward was published in 2000 in the New Zealand Public Health Report (8), a journal designed for those involved in planning and delivering public health strategy and services in NZ. My co-authors were key stakeholders who well understood the challenges:

Dr Michael Baker, who was working as a public health physician for the national surveillance unit at the Institute of Environmental Science and Research (ESR); Dr Julia Carr, a public health medicine registrar and the main author on a 1999 National Health Committee report that reviewed national strategies to deliver immunisation to children who were under-immunised (53); and Dr Osman Mansoor, a public health physician who had been working for the MoH in charge of the NIP.

4.2.1 Historically low immunisation coverage

At this time there were no reliable regular childhood immunisation programme coverage estimates for NZ. The article summarised the known information on coverage. The 1991- 1992 national survey established that <60% of children were fully immunised by the age of two years. Furthermore there were significant ethnic equity gaps with coverage at two years of age at around 42% for Māori children and 45% for Pacific children. The North Health coverage survey of 1996 suggested small improvements with overall coverage rates at two years of age around 63%, with 45% for Māori and 53% for Pacific. The 1995 National Immunisation Strategy established a target of achieving 95% of two year old children fully immunised by the year 2000 (50), and NZ did not appear to be on track to reach this national target.

The interpretation of the immunisation benefit subsidy (IBS) data was that there appeared to have been no improvement in coverage since 1996 (8). Estimates for 1997 to 1999 remained below those of 1996. It was not clear whether this was accurate or due to poor data.

4.2.2 Inaccurate immunisation coverage data

The only regular coverage estimates available were through accessing data from benefit claim forms which were likely to be unreliable data. These were forms that were submitted to claim the government subsidy (IBS) for each event. Refer 2.3 for a fuller explanation of this claiming system. The underlying issue was that these were claim forms designed for funding and not for the purpose of data collection. The main listed concern identified in the published literature for these data being unreliable was the low level of payment for the immunisation benefit. It had been shown that the reimbursement to the practice for the immunisation event was less than the cost to the practice of delivering the event (179) and lower than the claim for a child medical service. This may have encouraged a claim for medical services rather than IBS. It was unknown whether this was happening or not. Another possible error was the ticking of only one vaccine, even though three vaccines were given at the same time.

With the 1996 schedule change, the relative order of the hepatitis B and the combination vaccine of diphtheria-tetanus-pertussis and haemophilus influenza type b (DTPH) on the claim form changed and there was a corresponding change in the relative coverage estimates for the two vaccines. This suggested an error was occurring. Because the primary motivation was to claim for funding rather than provide accurate information there was no incentive in the system to provide accurate data. Furthermore, the coverage estimate was calculated by the number of claims divided by the target population and did not distinguish catch-up doses given outside the target range. There were an increasing number of practices that worked with a different funding model under which they were called ‘capitated’ and were given bulk funding for services and hence did not claim an immunisation benefit. These practices reported their immunisation coverage rates directly to the health authorities and this was combined with the benefit claim data. The accuracy of these figures also was unknown.

Other sources had reported higher immunisation coverage. A survey done by the Plunket Society called the *Plunket National Child Health Study* followed up 4286 children born in 1990 to 1991 and found 83% were fully immunised by two years (180). However, the validity of these findings was questioned due to a high loss to follow up (181). A Christchurch cohort study and an IPA in Rotorua had both reported recent coverage rates of over 90% of children fully immunised by two years of age (182,183). The Rotorua estimate was based on enrolled children, however, not the total population in the area.

4.2.3 Reasons for low immunisation coverage

Possible explanations for flat or dropping coverage rates identified in the commentary article included:

- Increasing public concerns about vaccine safety, highlighted by unfounded allegations that MMR vaccine was linked to autism and bowel disturbances.
- Changes in funding and delivery of health services including uncertainly around the number of children in capitated practices, and possibly increasing proportions of children with no regular GP and hence not being counted.
- No increase in the immunisation benefit payment despite increasing costs to the practices, reducing provider incentivisation to deliver immunisations.

4.2.4 NZ strategy

In 1993 the Public Health Commission had convened an expert group which reported back on immunisation (49). Refer 2.5.1. Based largely on this report, the Minister of Health launched the 1995 National Immunisation Strategy. Refer 2.5.2(50). There were several elements of the Public Health Commission's report not included in this strategy. These included establishing the position of a national co-ordinator; exploring the use of financial incentives and performance feedback to improve provider commitment; exploring ways to reduce indirect cost barriers; and increasing the kinds and number of resources to educate parents about immunisation.

By the time the strategy was launched the new schedule had already been decided upon, with some local coordinators already in place. Therefore, in effect, the only new strategies with potential to improve coverage were the new regulations which required immunisation checks on entry to an early childcare centre and school (*Health (Immunisation) Regulations 1995*), and the planned development of immunisation surveillance. However, the surveillance system did not materialise and no new resources were made available for the implementation of the new regulations, so it was therefore unsurprising that immunisation coverage had not improved.

In this commentary article (8) we challenged the NZ government by pointing out that in contrast to NZ, the UK, the USA, and Australia had all seen improvements in their immunisation coverage rates. Australia in particular had introduced a national register in January 1996 which provided an effective recall and reminder system, improved surveillance, and provided an information base for the delivery of provider and parental financial incentives. As a result they saw an increase in immunisation coverage from 64% to 85% fully immunised at two years of age over a two year period. Adding to the challenge for NZ, we included a comparison table of immunisation coverage from other Western Pacific countries and Pacific Island nations in which coverage estimates in 1998 for the three doses of pertussis vaccine in the primary course varied from the lowest rate of 81% in NZ to 100% in most Pacific Island nations.

4.2.5 Interventions to improve coverage

We also reviewed the NZ and international literature around evidence on interventions to improve immunisation coverage and identified six recommendations that we considered to be both evidence-based and relevant to the NZ situation. The first recommendation was the establishment of a national immunisation coverage surveillance system and its role in implementing the other six recommendations, as shown in Table 4.1 which is reproduced from page 13 of the article (8).

Table 4.1: Interventions recommended for NZ, source(s) of the recommendation and the role of a national immunisation coverage surveillance system

Intervention	Source of Recommendation	Role of national immunisation coverage surveillance system
Effective reminder and recall systems with every child on a primary care register	HRAS, Can, NVC, UST, NHC	Enhance enrolment on provider-based reminder/recall systems
Coordinated outreach systems to follow up children who do not respond to recall	HRAS, UST, NHC	Identify children not covered by provider-based systems and those who have missed immunisation
Feedback of provider performance, based on effective measurement of coverage and peer comparison	UST	Measure coverage at provider, regional and national level
Financial incentives to providers and/or parents to increase demand for immunisation	UST (parents) NHC (providers)	Provide mechanism for calculating incentives
Immunisation check at entry to schools and early childhood centres	Can, UST, NHC	Provide back-up source of individual immunisation information and means to analyse coverage at school entry
Education to promote immunisation, using a variety of channels	HRAS, NVC, UST, NHC	Enable targeting and evaluation of interventions

Key: HRAS: Health, Research and Analytical Services, New Zealand 1993
Can: Canadian review 1994
NVC: National Vaccine Advisory Committee, United States 1999
UST: United States Taskforce 1999
NHC National Health Committee, New Zealand 1999

4.2.6 Conclusions

We concluded that immunisation coverage had failed to reach national targets. The most important factor that likely contributed to this was the lack of a population-based immunisation surveillance system. This would inform and assist to ensure all children receive reminders, enable co-ordinated outreach, and to give provider feedback of performance. We recommended further analysis as to why the 1995 recommendations had not achieved their intended outcomes of increasing the priority for families to complete immunisation courses and suggested there was inadequate resourcing of the policy.

4.3 Strategies to improve immunisation coverage: Commentary 2004

In February 2004 I published a commentary article in the New Zealand Medical Journal (184) in support of an article published in the same edition by Tim Jellyman and Andrew Ure (185).

4.3.1 Attitudes to immunisation: a survey of health professionals in the Rotorua District

Drs Jelleyman and Ure had recognised that previous studies identified the attitudes and practices of healthcare providers as a more important determinant of immunisation rates than parental attitudes. To look at this in the NZ context they circulated a paper-based questionnaire to 278 healthcare professionals in the Rotorua region, including GPs, PNs, secondary service (hospital-based) doctors and nurses, public health nurses, preventive child health (Plunket) nurses, and community workers working with Māori children (Tipu Ora Kaitiaki). This survey had an 85% response rate. The authors acknowledged the potential bias based on self-reporting. Overall the respondents showed a strong support for recommending immunisation, with 94% supporting childhood vaccinations and 91% supporting science as the most important basis for recommendations. However significant areas of uncertainly were identified with differences between providers. Of note was that hospital-based providers appeared less confident around the scientific basis for immunisation. Just over one in ten (11%) of respondents felt there were unacceptable dangers, and 17% were unsure of the dangers of vaccination. While respondents generally felt that quality scientific research was the most important basis for recommending vaccinations, 36% were not sure if the MMR vaccine was a cause of autism or Crohns disease. At this point in time there was available scientific literature that had clearly demonstrated there was no link between the MMR vaccine and these diseases. The myth had been reported in the mass media, so the authors assumed that the healthcare providers were primarily influenced by the media discourse.

4.3.2 Commentary 2004

My commentary (184) initially focused on NZ's poor record with immunisation coverage, and restated the results of the 1992 national coverage survey (5). I identified that, despite low national coverage, there were NZ initiatives that showed it was possible to achieve and maintain high immunisation coverage, as demonstrated by the primary care providers in Rotorua (183). I summarised the key themes from the international literature on improving coverage around enhancing access and provider-based interventions and strategies to increase community demand. I argued that the role of the provider was possibly of greatest importance in the overall mix of issues needed to obtain high immunisation coverage, particularly the primary care provider. This is likely to be of more importance that the parental knowledge base, supported by a 1989 UK study that reviewed factors influencing immunisation uptake (186). The challenges in the NZ environment as described in the Jelleyman et al paper were that 11% of health professionals who answered this survey considered immunisation to have unacceptable dangers, a further 17% were unsure, and over one third of those surveyed were uncertain about the link between MMR and autism.

4.3.2.1 Conclusions

In summarising the research to date applicable to NZ, five significant areas were likely to affect immunisation coverage:

Healthcare provider knowledge and attitudes

The Jelleyman paper demonstrated a gap between healthcare providers' belief in the importance of science, and their actual knowledge of the science. This was supported by my own research team work, which demonstrated that healthcare professionals had significant gaps in their knowledge base, though they often failed to recognise these gaps (12). Refer Chapter 6 for a more in detail discussion of this research.

Adequate resourcing of services

There was inadequate funding to providers, supported by a study published in 1998 by McLeod et al showing a significant shortfall between immunisation subsidy and the cost of immunising at the practice level (179).

The antenatal arena and parents' knowledge and support at this time

My own recent research highlighted that the majority of mothers make their decisions around immunisation in the antenatal period and feel they lack information to make this decision (19). Furthermore decision-aids assist in improving their confidence and desire to vaccinate their infants (20) Refer Chapter 5 for a more in detail discussion of this research.

Misconceptions and anti-immunisation sentiment creating parental fear

Based on local service delivery knowledge, it was estimated that around 5-6% of the population were actively opposed to immunisation at that time. Anti-immunisation sentiment was not a new issue, but the concern was the influence on the wider community of this group, particularly with modern communication tools such as the Internet allowing rapid access to bigger networks. Local qualitative research identified that there was a high level of misconception around the issues surrounding immunisation with concerns around vaccine effectiveness and beliefs around natural approaches with good hygiene and nutrition likely to be adequately effective at preventing disease (187).

Access to services

Barriers identified included logistic, financial and cultural to making obtaining immunisation an even bigger challenge for parents.

In conclusion while I supported the NZ strategy which intended to track and offer services to children who were missing out, I highlighted that the considerable gaps in resource needs and that knowledge amongst healthcare professionals was also a barrier that needed to be addressed to assist with improving community-side fears and misconceptions.

4.4 Reducing inequities in immunisation coverage: 2009

In 2009 I co-authored an editorial in association with my colleagues in the University of Auckland, Associate Professor Cameron Grant from the Department of Paediatrics and Dr Rhys Jones from the Department of Māori Health, in the NZ Medical Journal around immunisation coverage (40). The focus of this editorial was on ethnic disparities. NZ had seen the introduction of the NIR in 2005 and overall improving infant immunisation coverage. However, significant disparities continued to be identified in 2009, particularly for Māori children in the infant schedule. This editorial was primarily motivated by the paper by Dr Belinda Loring et al that identified very low immunisation coverage for the 11 year old year school-based programme for tetanus vaccination with overall rates of 67%, and in particular an equity gap for Maori children (53% compared to 71% for all non-Māori) (188).

4.4.1 High rates of ethnic disparities in NZ compared to USA

Other countries had been successful in eliminating ethnic disparities in immunisation coverage. In particular in the US the indigenous to non-indigenous ratio for receipt of the primary series of vaccines ranged from 0.97 to 1.03, whereas in contrast in NZ the ratio for the same vaccine schedule ranged from 0.62 to 0.87 (189), with Māori infants having consistently lower coverage rates. The major difference was that the US had articulated elimination of ethnic disparities as a priority. They followed this up with the provision of comprehensive health services through their Indian Health Services and tribal health programmes, home visiting, utilising tribal community centres and schools for delivery, tracking immunisation status and providing free immunisations. NZ had articulated a similar aim in the NZ Health Strategy (190). However, we saw this as a weaker strategy, with its use of the softer words firstly to *reduce* and then to *eliminate* health inequalities.

4.4.2 Successful NZ model: The meningococcal B campaign

On a more positive note, NZ had shown itself capable of reducing inequalities with the delivery of the meningococcal B mass immunisation programme in 2004 to 2006 where ethnic differences were only 4% lower for Māori in the school-based programme and 9% lower than non-Māori in the primary care programme for children aged 6 weeks to 4 years. We suggested that the contributors to this success were an effective mass communication campaign, integrated information systems for both school-based and primary care delivery, more time and resources to focus on consenting, recalling, and outreach follow up (191).

4.4.3 Ways forward

NZ had many of the components present to make progress, including a stronger population focus in primary care with the PHOs, some of which also have tribal (iwi) affiliation. The lack of integration between databases was recognised as likely to improve with the progress with the NIR. There now was a good understanding of the need to engage the community more strongly, and better knowledge and expectations behind logistics for running immunisation programmes, both primary care and school-based.

At this time NZ was in the process of considering the introduction of the Human Papillomavirus Vaccine (HPV) to reduce cervical cancer in women. There was significant potential for this vaccine to reduce the equity gap for vaccine delivery and cervical cancer burden for Māori. This imperative might also help focus on the current poor capacity of the health system to delivery an effective national schedule of vaccines to all ethnic groups. The potential for cancer to be vaccine-preventable brought a broader perspective to immunisation programmes.

In the US the elimination of ethnic disparities coincided with their health system achieving higher immunisation coverage across the whole population. We did not consider this likely to be a coincidence, recognising that addressing the systemic problems responsible for inequalities in coverage would also lead to improved outcomes for all children.

Our recommendations to achieve disparity reduction were to:

1. Stimulate desire for the product via increased community communication.
2. Fund delivery of the product recognising the extra time and resources required to get informed consent.
3. Integrate (at a national level) the databases to enable every immunisation opportunity to be utilised.

4.5 Examining progress in immunisation coverage: 2009

In 2009 my colleague Dr Helen Petousis-Harris (as the first author) and I were invited to summarise the progress in immunisation coverage in NZ by 2009. This article documented the progress since the first formal schedule was drawn up in November 1960 (33). Disease control was summarised with the comments that NZ had eliminated polio and controlled diseases such as diphtheria. NZ's on-going challenges with poor immunisation coverage rates was identified with the figure from NIR data in 2009 at 77% of children fully immunised by their second birthday, a long way behind the national coverage target of 95%. Furthermore poor timeliness of delivery was also highlighted, with only 62% of infants receiving their fully primary course of three by six months of age. The resultant challenges continued to be in poor disease control, particularly for pertussis and measles. Controlling pertussis was recognised as being a key driver in the importance of the timing of the schedule.

4.5.1 The NZ childhood immunisation programme

The paper described the NZ decision-making process at that time where vaccines were licensed through Medsafe, the medicines and medical devices safety authority (33). An external advisory group - the Immunisation Technical forum (of which I was a member) made recommendations about new vaccines to the MoH based on safety, efficacy, cost-benefit analysis and disease epidemiology. The immunisation schedule was reviewed every three years and final decisions are made by the NZ Treasury. Service delivery for the infant programme is universally via general practice, with outreach services for those who miss out. Delivery is via PNs, medical practitioners, registered midwives, or other persons allowed under the *standing orders* regulations. Vaccinator training is recommended for all nurse vaccinators and compulsory for those who receive authorisation from a medical officer of health to administer vaccines without medical practitioner oversight. Funding for the programme was discussed and the inadequate funding for the providers was identified as a barrier as shown by our 2009 study (30). Refer Chapter 7.

4.5.2 Attitudes to immunisation

Community and parental attitudes were summarised, acknowledging that traditionally NZ had a vociferous anti-immunisation lobby and around 4-6% of parents actively declined vaccination for their children. However the greater challenge was seen as addressing the much larger group who lacked confidence in the programme. It was recognised that regular data on attitudes were not being collected in NZ, so it was unknown whether attitudes had quantitatively changed since the last national survey in 1991/92 (5). Anecdotal knowledge of change was through the national 0800 line run by IMAC, which takes calls from both the public and health professionals. The role of the media in having both positive and negative effects on immunisation coverage was identified, with the negative reports in NZ national newspapers in 2005 over the NZ tailor-made meningococcal B vaccine resulting in cancellations of appointments to vaccinate their children by concerned parents. Conversely, there was a significant increase in seasonal influenza vaccination uptake seen following the concerns with the 'bird flu' in 2008.

4.5.3 Barriers to improving immunisation coverage

In summarising the key barriers to progress in improving immunisation coverage, we concluded that there were a mixture of challenges with concerns over healthcare provider and public attitudes, issues for those with low family income and specific ethnic groups, problems with technical PMS and NIR interface issues, staff turnover, the age of enrolment of the infant in the practice, and providers missing opportunities to immunise when infants attended for other reasons and were overdue their immunisation events. These identified issues were from our own research discussed further in Chapters 5 to 8. The historic problem with the lack of reliable data was overcome with the advent of the NIR in 2005. However, data quality and interface issues with primary care PMSs remained for some time.

Our summary of barriers that needed to be further overcome to improve coverage were:

1. The financial costs for practices – the level of subsidy being much lower than the actual cost of a stand immunisation event.
2. The knowledge and attitudes of both parents and professionals – a confident professional can have a significant influence on parents; however both professionals and parents can also be influenced by scare stories and myths.
3. Social deprivation and having a Māori or Pacific ethnic background (both barriers to accessing services).

4.5.4 Factors that can improve immunisation coverage

Factors that were present, to variable degrees, in the NZ environment at the time that were likely to be having a significant positive effect on coverage were:

- Early enrolment of children creating earlier engagement with families.
- A well trained and stable general practice workforce.
- An effective practice management alert system.
- Follow up missed opportunities at every visit

From this article we concluded that, despite overall low immunisation coverage, there had been improvements over the recent years. Some general practices did achieve coverage of over 90% of two year olds enrolled with them. Factors associated with higher coverage in individual practices were a strong commitment to immunisation, a stable workforce, and the early enrolment of infants. There had been some narrowing of the equity gap between the different ethnic groups, although vaccination rates remained considerably lower for Māori and children from more deprived backgrounds. Rates for Pacific children had significantly improved although they still had high rates of delayed vaccination. To gain further improvements in coverage there needed to be a focus on better use of the PMS, fewer missed opportunities at the practice level, closer relationships with the practice population, and better education of health care professionals and families.

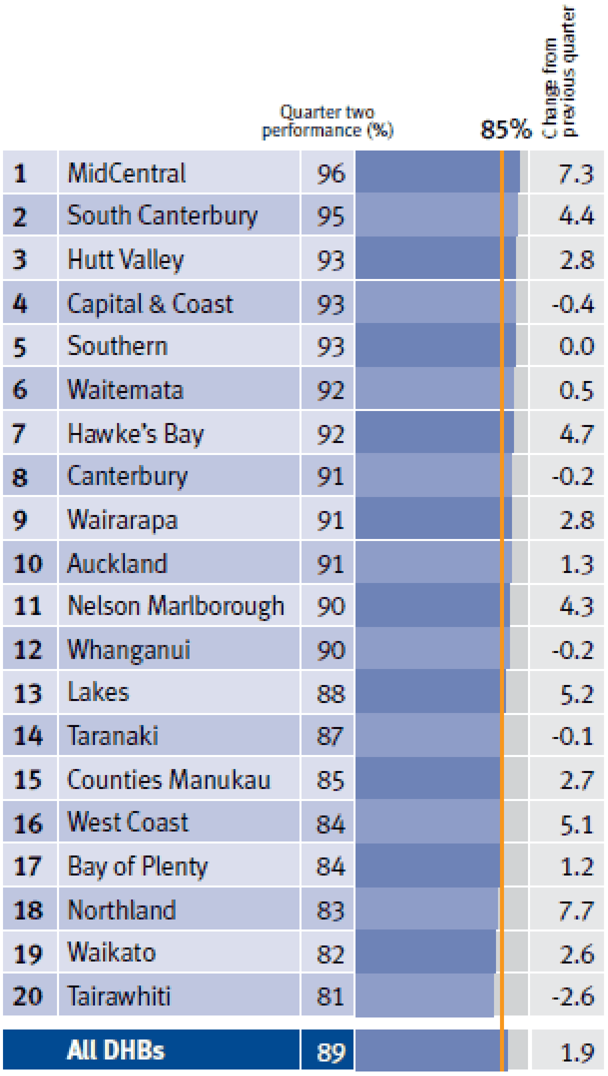
4.6 The success story: 2012

In 2011 I delivered a key note presentation titled *90 percent and beyond* at the New Zealand National Immunisation Conference in Wellington where I summarised the research with which I had been involved on immunisation coverage, the barriers, and the facilitating factors. I subsequently produced an invited paper for journal *Expert Review of Vaccines* on the factors behind the gains in immunisation coverage in NZ. This paper, which focused on the gains and the reasons for the gains, summarised much of the research in this area (32).

4.6.1 Goal setting/measuring and monitoring

The importance of the setting of strategic goals by the MoH was acknowledged. However, the earlier MoH strategies had failed to gain much traction until the implementation of the NIR as the core tool for supporting delivery, reporting, and monitoring. This was slow in coming, with its arrival finally hastened by the imperative of the rolling out of the national vaccination programme to control the meningococcal B epidemic. Without this programme, the implementation of the NIR may have been even more delayed.

The importance of the NIR is particularly recognised for its ability to monitor and give feedback to the different service levels in real time. In 2008 a government initiative was launched to make improving immunisation coverage one of the ten key public health priorities, subsequently reduced to six with childhood immunisation coverage remaining the only direct child health target on the list. This was seen as a strong driver for action in the sector, and was particularly propelled by regular public feedback of progress, which included regular public media publications comparing the achievements of all the DHBs. Refer Figure 4.2 for an example of the style of public feedback on progress (192).



		Quarter two performance (%)	85%	Change from previous quarter
1	MidCentral	96		7.3
2	South Canterbury	95		4.4
3	Hutt Valley	93		2.8
4	Capital & Coast	93		-0.4
5	Southern	93		0.0
6	Waitemata	92		0.5
7	Hawke's Bay	92		4.7
8	Canterbury	91		-0.2
9	Wairarapa	91		2.8
10	Auckland	91		1.3
11	Nelson Marlborough	90		4.3
12	Whanganui	90		-0.2
13	Lakes	88		5.2
14	Taranaki	87		-0.1
15	Counties Manukau	85		2.7
16	West Coast	84		5.1
17	Bay of Plenty	84		1.2
18	Northland	83		7.7
19	Waikato	82		2.6
20	Tairawhiti	81		-2.6
	All DHBs	89		1.9

Figure 4.2: Health targets for DHBs published by the NZ MoH 2013

Goal setting and the ability to measure and monitor progress were seen as fundamental to the improvement. The other barriers to be overcome are very much interwoven i.e. the effects via the environment, the health services and staff, and the parents and families are all interconnected.

4.6.2 Systems and provider practices

Our research identified a range of barriers at the service delivery level, the most important of which were structural and organisational aspects. The primary factors are the age of enrolment of the infant with the earlier enrolment the better; the type of PMS; and the presence of a stable practice with low staff turnover. Secondary factors are the functioning of the healthcare team; having well-supported staff with dedicated time for immunisation service delivery; and positive, engaged relationships with the children and their families. Thirdly, the healthcare professional themselves feeling both confident and knowledgeable is important. While gaps in knowledge are important to address it is likely that the confidence to communicate effectively with parents is the more important factor. Refer Chapters 6 and 7. In summary *A confident, engaged healthcare professional working in a supportive stable team and given enough time and resources, can utilize effective systems to maximise effective enrolment, precall and recall, and take every opportunity to reduce missed opportunities to* *immunize when the children are in the practice* (32). There are also challenges in primary healthcare with competing priorities for providers, highlighting the importance of immunisation champions within practices to keep the focus and prioritise attention.

4.6.3 Family and child characteristics

It has been recognised internationally that receiving the first vaccination event on time is one of the strongest and most consistent predictors of subsequent complete immunisation (193). Parental decision-making usually occurs in the antenatal period, and good health provider engagement in this period of time can make a significant difference to parental decision-making. Conversely, parents receiving misinformation in this period can significantly negatively affect immunisation uptake. Refer Chapter 5.

4.6.4 Environmental issues: poverty

The issue for children coming from more vulnerable families, particularly lower socioeconomic and some ethnic groups, is a challenge for all immunisation programmes. NZ has a long history of significant equity gaps, which in more recent years has shown rapid reductions. While equity gaps are not entirely eliminated, excellent progress has been made. Refer Chapter 2.7. It is evident that a well-supported primary care service delivery, including an outreach component, can effectively deliver to high-needs groups and overcome equity gaps in their enrolled populations.

Enrolment and early engagement with providers is necessary, to identify and offer services to all children. If enrolment does not occur at birth or soon afterwards, the child is much less likely to be immunised on time. NZ uses outreach services for children identified at the practice level as missing out on immunisation services. These services are expensive, however these are usually the higher needs group of children and hence are of importance. Effective primary care services and reducing missed opportunities can reduce the amount of children needing to be referred to outreach services. Refer Chapter 8.

4.6.5 Environmental issues: other

There are also broader environmental influences. The impact of community, parental, and health professional knowledge is likely to be important on confidence in the safety and effectiveness of the programme. NZ has always been seen as having an active anti-immunisation voice in the traditional and social media networks. This is likely to have lessened, or become more marginalised over the more recent years. This may be due to learning how to more effectively communicate science at different levels and to different audiences. Associated with this is providers working closely with the media, being available and accessible and recognising media drivers are, at times, different from public health programme needs. Refer Chapter 5.

4.6.6 Conclusions

Based on the accumulated research, effective immunisation programmes need to pay attention to gaining and maintaining high immunisation coverage and timeliness of delivery to be most effective. NZ has come from a background of mediocre immunisation coverage for its childhood programme to achieving reasonably high coverage rates, better timeliness of delivery, and closing of the traditional equity gaps. Prioritising immunisation at the national and district levels, with goals and priorities and having the right tools to measure coverage, public reporting, and feedback loops appear to have underpinned the progress.

To make this happen requires putting a strong focus on the antenatal period to engage and support parents; maximising effective systems at the district and local service delivery levels that particularly include attention to early enrolment, engagement, precall, audit and prioritisation of immunisation in the provider environment; supporting providers with good working environments, encouraging and supporting champions; and with the wider environment creating greater community confidence in immunisation working with social networks and the broader media.

The final caveat is that although NZ has made excellent strides with relatively limited resourcing it is yet to reach the target of 95%. Whether the current strategies would be adequate to continue progress or if further strategies would need to be considered such as increasing incentives to providers, incentivisation approaches for parents, or large mass media campaigns remains to be seen.

4.7 Summary of Chapter 4

This chapter summarises commentary on immunisation coverage in NZ from 2000 to 2012. In 2000, NZ was doing relatively poorly for immunisation coverage for the childhood national schedule, and early commentary focused on strategies that could be implemented to improve the situation. Many strategies were implemented and the commentaries reflect progress over this time. As immunisation coverage improved, attention shifted focus to reducing the equity gaps, and then further to improving timeliness of delivery. The most recent commentary in 2012 summarised the progress to date and our research that had contributed to the knowledge base and been part of influencing strategic direction over this period.

CHAPTER 5 PARENTAL KNOWLEDGE, ATTITUDES AND DECISION-MAKING FOR INFANT IMMUNISATIONS

5.1 Outline of Chapter 5

International literature identifies that most significant barriers to immunisation coverage relate to poverty, delivery systems and provider practices, and family and child factors (194). This chapter focuses on family and child factors. It aims to present and discuss our published research since 1997 concentrating on NZ parents, particularly mothers, and their decision-making process around obtaining immunisation for their infants. This research covers parental knowledge, attitudes and their decision-making processes in the antenatal period.

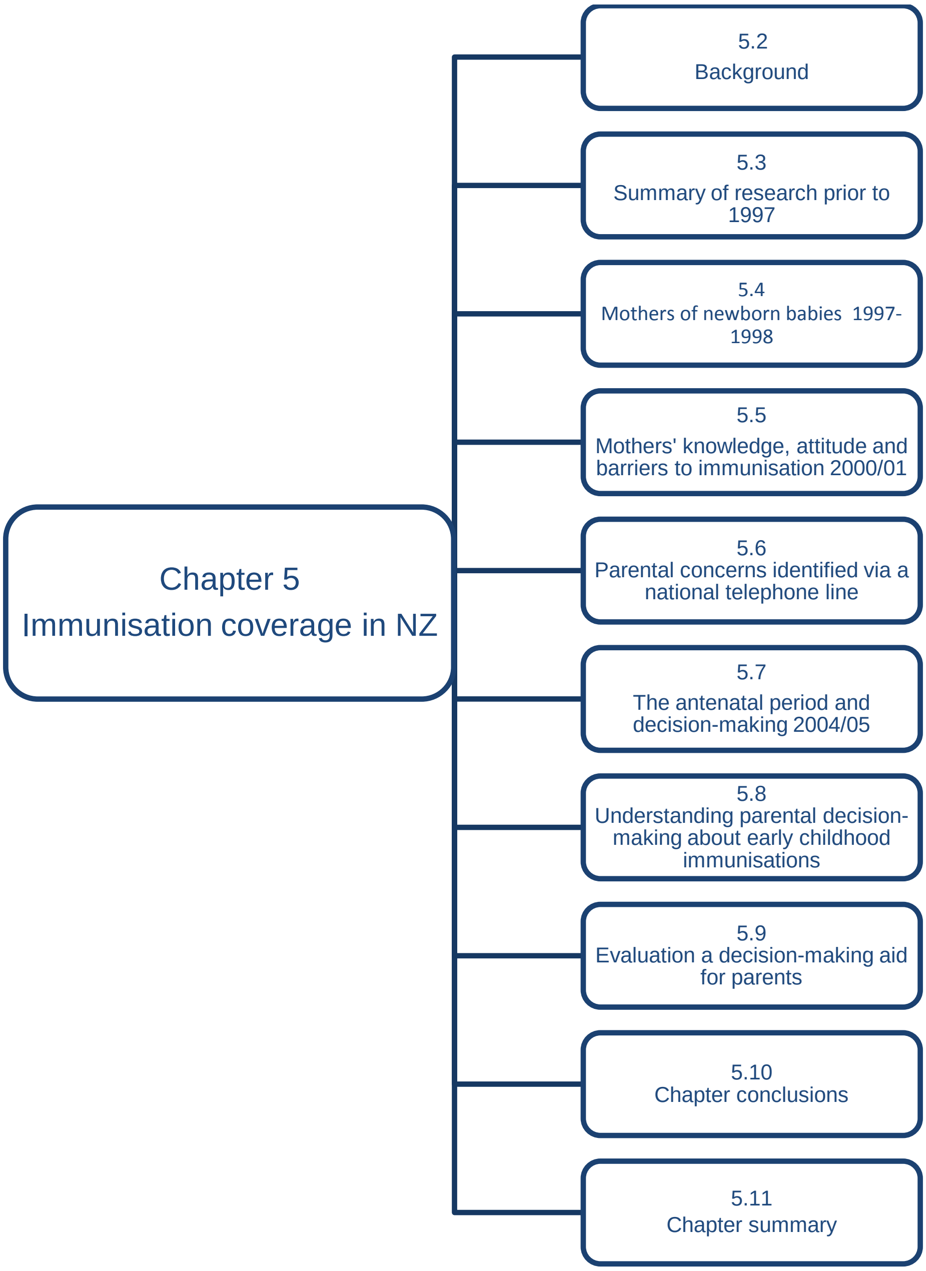

Chapter 5
Immunisation coverage in NZ
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Figure 5.1: Outline of Chapter 5

5.2 Background

In my role as the northern regional immunisation coordinator in 1998, I became aware of the low rates of immunisation coverage for NZ children at that time. Refer Chapter 2. There was very little published NZ data on the reasons for low immunisation coverage. Maternal knowledge and attitudes to immunisation had been explored internationally and were well recognised as one of the important determinants in the uptake of immunisation for infants. Refer Chapter 3.3. Recognising this gap in the NZ research, my colleagues and I undertook a range of studies over the next 10 years, discussed below in chronological order. The first study, conducted in 1999, was a postal questionnaire of mothers of new-born infants (7). This was followed by a telephone survey of mothers of infants under 18 months of age (10) and in-depth interviews of mothers of children aged 18 months to 4 years (9). Moving from there to consider the antenatal period, we undertook a survey of parents recruited antenatally (11), then focused on the antenatal period initially with a survey of mothers in their third trimester of pregnancy (19) followed by the development and evaluation of a decision-making tool for parents in the antenatal period (20).

5.3 A summary of NZ research prior to 1997

The 1991 national coverage survey involved interviews from parents in 706 households and included a questionnaire around their knowledge and attitudes to the childhood immunisation programme (5). The significant findings from the parental responses were firstly that 89 to 98% surveyed stated that childhood immunisations were ‘important’ with similar rates of support for requirements to check immunisation records prior to school entry. This was lower for immunisation against measles in one region, the central North Island, with only 75% stating that measles was an important disease. Secondly, there was low knowledge of contraindications and a highly-expressed desire to receive more information from providers. In particular 87% to 89% of parents wanted reminders of when their infant immunisations were due. Concerns expressed included 8% of parents believing they do not need to immunise if their child is healthy, 5% unsure and 27% believing that immunisation injections are too upsetting or painful for young children.

A qualitative study by White et al, published in 1995, undertook seven focus groups and 21 individual interviews with 67 parents in metropolitan Auckland, of whom 97% (65) were mothers (195). This study found that many mothers felt they faced a dilemma about immunisation and were anxious about the need to make a decision for their infant. Furthermore, they felt the burden was on them, the mothers, as the predominant caregivers to make this difficult decision. Parents identified that they had limited knowledge and experience of VPDs. Some viewed the concept of ‘protection’ as a useful frame; others perceived immunisation delivery was socio-politically driven and felt distrustful. NZ European mothers tended to express worry about getting their child immunised more than Pacific Island and Māori mothers, but less concerns over the diseases. There was a general feeling that good personal hygiene and nutrition made it unlikely that children would contract the diseases and that vaccines were ‘artificial immunisation’. This created a dilemma for many, particularly better educated NZ European mothers, who saw the vaccines as able to cause severe damage. For those who were less concerned about perceived vaccine side effects, the major problem was remembering when the immunisations were due. Younger and first time mothers particularly were concerned about watching their baby in pain having an injection.

5.4 Mothers of new-born babies, 1997 - 1998

5.4.1 Background

In July 1996, significant changes were made to the payment of the maternity services benefit. Postnatal services had been paid on a ‘fee-for-service’ basis and this was altered to a set capped amount of the ‘postnatal module’. Prior to this time, the traditional six week check which was delivered at the general practice was claimed as a fee-for–service event. There was a concern raised that the change in payment meant that this six-week check may be less often delivered in general practice. Since the six week immunisation event was delivered alongside the six week check, there was concern that this could also affect the uptake of the first immunisation event. Anecdotal reports at the time suggested that this payment change might be a contributor to the reports of dropping immunisation rates being reported at the time (196).

I was involved in research in 1998 to investigate the uptake of the six-week check, associated six-week immunisation rate and breast feeding rates. Included in this question were maternal reasons for not receiving the six-week check and/or immunisation. I utilised the services of two medical students on summer studentships, Nicola Whittle and Anna Tai, who undertook the research. An academic nurse, Doreen Hounsell, helped with advising on the design of the recruitment strategy and the questionnaire, and the biostatistician Elizabeth Robinson undertook the statistical analysis. I note Doreen has since died and I value her friendship and support as an important mentor to the start of my research career.

5.4.2 Methods

The design was a prospective prevalence survey using maternal self-report, which involved a postal questionnaire to mothers of infants after the six-week immunisation event was due (7). The researchers recruited women postnatally between the time periods of November 1997 to February 1998. Recruitment was undertaken at all the major maternity hospitals in the Auckland urban region: National Womens, Waitakere, North Shore, Middlemore, Howick Obstetric and Papakura Obstetric hospitals. The percentage recruited from each birthing centre was based on the percentage of the total Auckland regional births per annum for each centre using 1997 statistics. The researchers attended each hospital at times based on the hospital and researcher convenience and approached all mothers (from two to 36 hours postnatal) of infants born at or beyond 36 weeks gestation who did not require Level 3 paediatric care. Participants were given an information sheet and a consent form, translated into Chinese and four Pacific languages for those with English as a second language. No home deliveries were recruited; at that time, 1997, home deliveries were approximately 2% of all urban Auckland births (7). Questionnaires were posted out at ten weeks postnatal, also in the translated language where necessary. If questionnaires were not returned after four weeks, telephone contact was attempted, followed by a further postal questionnaire. Based on maternal recall the six-week postnatal rate, breast feeding rates and six-week immunisation rates were calculated and the maternal reasons for failure to obtain the six-week check, non-immunisation and changing from breast feeding were coded and quantified. A multivariate analysis was undertaken using the explanatory variables of maternal age group, ethnicity, parity and type of LMC. Logistic regression was used to investigate the relationship between these factors and the outcomes.

5.4.3 Results

Five hundred and four women were recruited. Less than 5% of those approached declined to participate but there is no information on those who declined. Of the 504 questionnaires sent out, 17 were not included in the study due to having the wrong address, address unknown or unclear, consent not signed, or declined to participate. In total 401 questionnaires were completed, a return rate of 82%. The ethnicity of the participants was 57% NZ European, 12.3% Māori, 8.3% Samoan, 6.8% Asian, 2.5% Cook Island, 1.8% Tongan, 1.3% Niuean and 10% other. For 44.7% this was their first baby and 33.7% had one other child. The LMC was identified as an independent midwife by 31%, hospital midwife by 70%, GP by 18% and a hospital specialist by 5%.

Overall, 97.7% (388) mothers received a six week check. There were no clear reasons established for those 13 who did not. A total of 359 (90.2%) of mothers stated their infant had received his/her six-week immunisation event by eight weeks. Of the 39 who had not received an immunisation, Table 5.1 reproduced from Turner et al 1999(7) lists the reasons:

Table 5.1: Mothers' reasons given for not obtaining the infant 6 week immunisation

Maternal reason for not vaccinating	N	%
Choice to delay until the child is older	21	43
Unwell child	12	25
Personal family choice	10	20
Unwell mother	2	4
Access issues	2	4
Concerns re vaccine side effects	1	2
Other	1	2
TOTAL	**40**	**100**

Logistic regression was used to investigate the effect of maternal age, maternal ethnicity, type of LMC, type of health professional giving the six-week check, family order of the infant (first born or not) and on whether or not the infant was immunised. The age of the mother (p=0.02) and the person giving the six-week check (p=0.02) were found to affect whether the child was immunised. The type of LMC had no effect on the outcome. Infants seen by GPs at the six-week check had a significantly higher rate of immunisation (p =0.02) than those seen solely by other health professionals. Younger mothers (those aged 15 to19) had the lowest rates of immunisation in their infants and mothers aged 20 to 24 years had the highest rates.

5.4.4 Conclusions

There were limitations to this study. Firstly the 82% response rate, while excellent for a survey of this nature, does mean there is no information on the missing 18% who did not return the questionnaire and the further 5% who declined to participate at the start. Rates of return for Māori and Tongan mothers were lower than the expected rates based on the census data. So, while the high uptake rate of 97.7% of the six-week check was very promising, it is not fully representative. However, there was a nationwide study in 1994 undertaken on 1819 children giving similar results showing a 94.8% uptake of the six-week check (197).

The most important finding of this study was that a child who had a six-week check by a GP was significantly more likely to be immunised than a child who had a six-week check from another health provider. This could be interpreted as either children attending a GP have more opportunity for immunisation or mothers attending someone other than their GP may be less inclined to get their children immunised. Either way, this study highlighted the concern that splitting the delivery of the six-week check from delivery of the first immunisation event appeared to have a negative impact on the rate of immunisation uptake and lent support to the recommendation to reinstate the six-week check back to the general practice. In March 1998, the payment of the infant six-week check was altered to give a direct fee-for-service payment to the general practice, which it was hoped would improve this situation.

Maternal characteristics highlighted from this study were the higher likelihood of younger mothers (aged 15 – to 19 years) having unimmunised children. This finding similarly had also been shown in the results of the 1991 national coverage survey (5), in which there was also a trend towards older mothers having lower immunisation rates, although the absolute numbers were very small. These mothers may be more likely to be influenced by anti-immunisation sentiment.

In terms of maternal reasons of those choosing not to immunise, just under 50% (n=21) chose to delay until the infant was older. This was raised this as an important issue that had not previously been noted in the NZ literature. However, it does fit with some of the qualitative concerns expressed in the White et al publication where mothers felt conflicted about immunisation (195). One quarter of mothers delayed immunisation because they stated their infant was unwell. This fitted with the international evidence that the biggest missed opportunity (MO) for immunisation was due to false contraindications, such as delaying due to minor illnesses (198).

5.4.5 Recommendations

The recommendations from this research were firstly the importance of considering the effects of policy on immunisation; in this case, splitting the six-week check from the six-week immunisation event and secondly, the importance of focusing on younger mothers to support higher uptake. The possibility that older mothers had other influences was noted and needed further exploring. Finally, the reasons for maternal decisions to delay needed further consideration, particularly the expressed feeling that the infant was too young at six weeks and the delay due to perceived illness as a contraindication.

5.5 Mothers’ knowledge, attitudes and barriers to immunisation, 2000-2001

5.5.1 Telephone questionnaire 2000

5.5.1.1 Background

By 2000, there was no indication of improvement in immunisation coverage rates; failing the national targets (50) and in particular, rates for Māori and Pacific infants were still much lower than other groups (43). Results from the regional immunisation coverage surveys showed that caregivers throughout the country expressed a desire for more information from immunisation providers regarding immunisation and depending on the region, 2 to 8% of caregivers felt that immunisation was not important (5). Six years later (by 1996) this sentiment was held by 3.7 to10% of caregivers (43).

Wanting further information around parental knowledge and attitudes, our next piece of research was a telephone survey. This was undertaken with Dr Helen Petousis-Harris as the Principal Investigator and Ngaire Kerse as advisor. The objective was to research the knowledge, attitudes and misconceptions of NZ parents around vaccines and the diseases. We used funding from the IMAC and commissioned the services of a market research company, NFO CM Research (National Family Opinion; Central Market Research), to undertake the recruitment and to deliver the survey. The company was a leading market research consultant in NZ at that time. This was published in 2002 (10).

5.5.1.2 Methods

We selected a sample size of 500 NZ mothers with a child in their household of up to 18 months of age. This number was chosen based on prevalence estimates assumed to have a maximum of 4.4% difference with 95% CIs. In discussion with NFO CM Research the potential respondents were identified by two methods. The first method was undertaken in 16 of the main urban areas and involved a random walk methodology using a continuous face-to-face survey approach. This involved a researcher going door-to-door on a representative sample of the city streets using maps. Streets considered too dangerous for an interviewer were excluded. The interviewer knocked on each consecutive door over 50 weekends in the one year. If there was no answer they tried again later; if inconvenient, they returned at a more convenient time; if a refusal, they moved to the next house. When they completed six interviews, it was considered a cluster and they moved to another area. This methodology identified households with mothers of young children who consented to be telephoned for the survey. This sample pool was further supplemented from a database where the required respondents had been interviewed from a previous survey and had given permission to be recontacted.

We developed a questionnaire, modified from a large UK survey undertaken to evaluate parental knowledge and attitudes in the UK (186). Questions included gauging knowledge and attitudes around disease severity, efficacy of vaccines and disease transmission. Parents were also asked where they obtained their information about immunisation from and how they felt about the information received. The telephone questionnaire was undertaken between 1 April and 11 May 2000. Analysis was done using Surveycraft and EpiInfo2000 and Chi Square statistic was used to test differences between subgroups.

5.5.1.3 Results

A total of 1266 households were approached and 818 met the inclusion criterion. Of these 61% (n=500) completed telephone interviews. Of the 318 who did not participate in interviews the following reasons were listed: Appointment not completed (n=7), unobtainable for undertaking appointment (n=274) and decline (n=37). The demographics of the 500 interviewed were listed by their age, region of domicile, ethnicity, joint household income and maternal education level. Parents without telephones (none), minority groups including Māori (9%) and Pacific (7%), and those of lower income were under-represented compared to NZ census data 1997/98.

Overall, 62% of mothers interviewed used a midwife as their LMC during their last pregnancy and of these, 45% identified their LMC as an independent midwife. There was an ethnic difference in type of LMC with 12% of NZ European mothers using a hospital-based midwife compared with 37% of Māori. The use of a specialist increased with age, with 42% of women over 40 using a specialist compared with 18% overall. Table 5.2 reproduced from Petousis-Harris et al 2002 (10) shows responses of mothers to specific statements about immunisation.

Table 5.2: Summary of agreement with statements made to mothers in NZ about immunisation

	Strongly Agree %	**Somewhat Agree %**	**Total Agree %**	**Neither/Nor %**	**Somewhat Disagree %**	**Strongly Disagree %**	**Total Disagree %**	**Don't Know %**
Measles can be a serious disease for young children	67	20	87	3	5	2	7	3
Vaccines are generally effective at preventing these diseases	62	26	88	2	4	3	7	2
If you keep children clean, well fed and otherwise healthy they will not catch these diseases	8	10	19	4	24	52	76	1
Breastfeeding stops children from catching these diseases	8	18	27	6	30	32	62	5
Parents and caregivers have a responsibility to ensure children are immunised to prevent these diseases from spreading in the community	78	11	90	3	2	4	6	1
Whooping cough is not a serious disease for young children	6	3	10	1	6	81	87	2
General immunisation of children helps to protect those children who cannot be immunised themselves due to illness	48	25	73	4	7	8	15	7
Childhood diseases are no longer around much so you don't have to worry about immunising against them	4	4	8	2	15	75	89	1

Subgroup comparisons

By LMC status

Respondents who used a midwife as their LMC were less likely to perceive measles as serious for children, compared to those who saw a doctor (84% compared to 92%; p ≤0.029). Those who used a midwife, rather than a doctor, were more likely to agree that breast feeding stops children from catching VPDs (30% compared to 23%; p<0.03). The perception that childhood diseases are no longer around, so you do not have to immunise against them any longer, was more likely to be held by those mothers who used a midwife rather than a doctor (10% compared to 4%; p<0.04).

Of those women who had a midwife as their LMC, 61% recalled discussing immunisation, compared with 81% of those who saw a GP and only 20% of those who saw a specialist (Chi-square 73.61,p<0.001). Comparing those who saw a GP with those who saw a midwife showed that recall of immunisation discussion was higher in the GP groups (p<0.0036). Those mothers with a midwife LMC, compared to a GP, were more likely to say the information was confusing (14% compared to 4%; p=0.026) and less likely to say they had had enough information for them to make a decision (83% compared to 90%). Of the 19% (n=96) of respondents, who did not discuss immunisation with their LMC, but who obtained information from another source, 53% accessed Plunket. Overall, 23% (n=115) of women did not recall receiving any information.

By age group

Mothers over 40 years of age were less likely to agree that vaccines were effective (71% compared to mean response rate 88%; p=0.015). Mothers over 40 years were less likely to agree that parents and carers have a responsibility to ensure children are immunised to stop VPDs spreading (71% compared to mean response rate 90%; p ≤0.007). Older mothers were more likely to disagree with the statement that general immunisation of children helps protect those children who cannot be immunised due to illness (29% compared to 14%; p=0.013). However, mothers over 40 years were less likely to agree that keeping children clean, well fed and otherwise healthy will stop children catching VPDs (4% compared to 19%;p= 0.025).

Over 90% of mothers aged less than 24 years or over 40 years recalled obtaining some sort of written information compared to 75% of mothers between 25 to 39 years. Around 20% of those between 25 and 39 years stated they received only verbal information, which was higher than in other groups(p=0.066).

By ethnicity

There was a wide variation in responses between ethnic groups to the statement around keeping children clean, well fed and healthy being sufficient to prevent them catching VPDs. Thirteen percent of NZ European agreed, 26% of Māori, 45% of Pacific, 58% of Asian, 40% of Indian and 22% of other agreed. Pacific Island (33%) and Asian (33%) mothers were most likely to agree with the statement around childhood diseases being no longer around so much so you do not need to worry so much about immunising children compared to overall 8%, Māori 11%, Indian 0% and NZ European 4% (p=0.0074).

5.5.1.4 Summary

There were some limitations to this survey with under-representation from parents with no home telephone, Māori, Pacific and lower income parents. However, despite this, there were useful and important findings.

Overall, respondents were generally positive towards immunisation with 88% of respondents feeling that vaccines were generally effective. Conversely though, 12% of mothers did not think that vaccines were effective. When asked whether or not they immunised their child, 95% (n=384) of mothers who did answer the question said they had immunised their children, although another 19% (n= 95) declined to answer this question. If we assumed all the decliners did not immunise, of the total group, possibly only 76.8% had immunised their children.

Seventy percent of mothers agreed they had received enough information to make an informed decision; this was particularly high among younger mothers under 24 years of age, where 93% felt they had received enough information. Mothers were polarised about the focus on the information they were given, with 43% considering there was too much focus on the positive side of immunisation. Just over one third overall still felt they wanted more information and 21% felt there was an element of coercion delivered with the information to persuade them to have their child immunised. Despite this, only 6% stated they considered this was unfair.

The findings that older mothers were less likely to consider measles serious and vaccines less effective were unexpected, although did match the trend noted in the 1999 survey (7) We proposed that older first-time parents may be more questioning and less convinced of the medical model and parents having late pregnancies question more than with their earlier or first pregnancies.

Of particular concern was the finding that approximately one quarter of mothers thought that breastfeeding (27%) and good hygiene (19%) would prevent these diseases. This showed a high level of misunderstanding of the diseases and their consequences. Furthermore, parents appeared to have very little understanding of the concept of herd immunity offering protection to others. Despite this, there was still a strong sense of responsibility to others in the community.

The differences between ethnic groups were harder to interpret. It is possible that some of these large differences particularly seen for Pacific mothers may be attributable to having English as a second language and the requirement of interpretation of the statements.

It was evident that immunisation did not always appear to be discussed, particularly with specialists and midwives. We raised the question of whether LMCs were less likely to discuss the issue with parents having second or subsequent children, which may be supported by the finding that younger mothers were more likely to receive written information.

5.5.2 Focus groups and one-on-one interviews 2001

5.5.2.1 Background

Following the questionnaire, we wished to undertake more in-depth qualitative research to further explore knowledge and attitudes and to identify existing and potential barriers to parental uptake of immunisation for children under the age of two years. This research we undertook with Helen Petousis-Harris as the Principal Investigator, working with Felicity Goodyear-Smith from the Department of General Practice and Primary Health Care and Sue Godinet from NFO CM Research. Sue had extensive experience in qualitative research and she undertook, with her colleague from NFO CM Research, all the NZ European focus group and interviews. The Māori study was via collaboration with Tomaiora Māori Health Research Group, University of Auckland. The Māori focus groups and interviews were undertaken by Brooke Arlidge of Tomaiora with support from Sally Abel of the Department of Māori and Pacific Health. Siniva Sinclair assisted us with data analysis and Sue Crengle and Stephen Buetow with editorial input. Funding for the study was provided by GlaxoSmithKline, who had no involvement in the study design or implementation. The four study authors were involved in the analysis of the data. This was also published in 2002 (9).

5.5.2.2 Methods

Purposeful sampling was undertaken for focus groups and one-on-one interviews to recruit both NZ European and Māori mothers and a mixture of mothers who had fully immunised infants, partially immunised or not immunised. Sampling Pacific ethnicity was considered, but not undertaken, mainly due to resourcing constraints. However, it was also thought that Pacific parents, similar to Māori, were more likely to have physical access challenges rather than emotional reasons for not completing their children's vaccination, hence Māori ethnicity was preferentially chosen. Ethnic group was via self-identification and immunisation status was verified by self-checking the child's Well Child book or by checking with the PNs. NZ European parents of non-immunised children were recruited with the cooperation of the Immunisation Awareness Society, the main NZ anti-immunisation/pro-choice parent group. Discussions and interviews were tape-recorded or notes were taken with parents' permission. Facilitators used enabling and projective techniques to allow parents to explore their knowledge and beliefs. Group discussions lasted between two and two and a half hours and interviews one hour. Separate focus groups were held with parents who did not immunise, those who immunised fully and those who partially immunised. All interviews were conducted in mid-2001.

Data collection and analysis were undertaken interactively. Emerging themes, topics, attitudes and behaviours were noted, and categorised into meaningful units. Content provided insight into intention and meaning. Expressions were observed, including the tone and emphasis of attitudes and behaviours as well as the degree of directness and spontaneity of expression. Verbatim comments were taken from the study to illustrate many of the findings. Validity was achieved by the use of projective techniques to identify parents' understanding, ideas and statements about immunisation and what actually occurred.

A subset of the participant responses underwent a further qualitative analytical process. Interview responses were collated and analysed to identify themes, which were combined through on-going discussion between three of the researchers (including myself) and re-reading of the transcripts until consensus was reached. The data were independently triple-coded as a consistency check and discrepancies resolved jointly.

5.5.2.3 Results

Seven focus groups and 16 one-on-one interviews were conducted. The focus groups comprised four to six parents and consisted of six groups of parents who had fully or partially immunised children, and one group who had fully unimmunised children. The one-on-one interviews were held with 12 parents who had started immunising and four who had not immunised their children. Four focus groups and seven individual interviews were held with NZ European parents, and three focus groups and nine individual interviews with Māori parents.

Overall findings showed a mixed picture of positive and negative attitudes towards immunisation. Six primary themes were identified and listed below with sub-themes as shown in Table 5.3 reproduced from Petousis-Harris et al 2002 (9). Note I have used the word 'vaccination' here, rather than 'immunisation' to be consistent with the language used in the original research.

Table 5.3: Emerging themes and sub-themes

Theme	**Sub-theme**	**Quotes**
Fear of vaccination	Immediate pain	*Well, you can see the needle being stuck into the body, the vaccination. And the holding down of the child to enable them to get the needle in them properly, the size of the needle*
	Long-term damage	*These vaccinations are quite dangerous in regards to them being brain damaged and just the certain types of effects that the kids get.* *I fear them getting damaged, the side effects.*
Vaccination is unnecessary	Diseases are rare and/or mild	*I don't think those [the diseases] are very serious*
	Own immunity will protect	*We just felt that if we looked after them properly at home and gave them nice clean faces and breast feed, that was all they needed*
	Interferes with 'natural' immunity process	*The homeopath said that by choosing not to vaccinate I am choosing to give him a healthier start, because from what I understand through her, you start on a back foot the minute you start vaccinating because it actually has quite a powerful effect to weaken the immune system; whereas for me, breastfeeding and not choosing to vaccinate I have actually strengthened his immune system twofold.*
Lacks knowledge about vaccination	Unconcerned	*Didn't worry about it. Still not worried about it*
	Would like more information	*I would want to know as much as I could about what the disease itself is. The risk, the risk of vaccination as well.*
Negative perception of health providers	Distrusting - suspicion of provider biases	*You went to [xx]; they talk about making an informed choice. The only information they gave me was pro-immunisation.*
	Uncaring of the individual/condescending	*They make you feel like, belittled, is that the right word? Lower than anyone else, you don't know anything as a mother.*
Difficulty accessing vaccination		*I think it would be better if they came to your house and hound you at the door 'Your kid needs an injection.'*

Theme	Sub-theme	Quotes
Supportive of vaccination	Informed on benefits and risks	*We have got an awesome health system that keeps our kids from getting sick and immunisation is one that keeps them from getting measles, mumps and things like that.*
	Positive- implicit trust, family tradition	*I was educated to vaccinate.*

Subgroup differences

While the general themes that emerged were consistent for Māori and non-Māori, there were some key differences. Māori deliberate non-immunisers were more likely to have older children who were immunised and they rejected immunisation for their younger children because of the painful experience of their older children and the lack of positive reinforcement when immunising. Those Māori parents who were non completers felt that they were judged for being uncaring parents. Māori parents also appeared to have more motivation to take up the three and five month events based on awareness of the need for immunisation certificates required by early childcare centres. Immunisers who took a traditional view appeared to take particular notice of other members of the whanau. In contrast, NZ European parents often looked to their friendship networks for guidance. Grandparents also appeared to have a stronger influence for many Māori parents in decision-making.

5.5.2.4 Summary and recommendations

We concluded that parents, as modern consumers, expect to take an active role in the immunisation decisions for their children. All parents consistently shared the desire to keep their children healthy and disease-free, but often had underlying anxieties about the decision-making processes. From this research, we concluded that parents are motivated to complete the immunisation schedule when they perceived that the risk of the disease outweighed the risk of other factors. Mothers held a strong belief in the importance of the immune system to provide a ‘natural’ protection against disease and most mothers believed it important to build their child’s immune system through approaches such as breast-feeding, diet, good hygiene and good parenting. Drugs were often seen as being artificial, in conflict with the natural approach and therefore potentially weakening or suppressing the immune system in some way. Barriers to completion include the perceptions that the immunisation experience is painful and vaccines can cause harm. Parents who did not complete their child’s immunisation series tended to focus on the harmful or painful consequences of the vaccines with minimal focus on the effects of the diseases.

We concluded that there were two types of barriers to immunisation - emotive and functional. This study focused particularly on the emotive barriers and we developed recommendations using the themes identified in this study to profile parents and aid in the development of intervention strategies. Refer to Figure 5.2 reproduced from unpublished IMAC data from 2002.

With parents who had completed their child’s immunisation events, there were those who viewed immunisation as an ‘insurance policy’ against diseases, which they perceived as real and relevant. A group within this group were mothers who immunised their children because it was a traditional practice among their family, whānau or peer group. This gave them confidence in their decision-making. We identified these groups of parents, whom we named the ‘Health Insurers’ and ‘Traditionalists’ as shown in Figure 5.2, as needing support and positive reinforcement for their decisions.

For those mothers who were less confident about immunisation, the diseases were seen as less relevant and the use of vaccines of greater concern. Mothers who had begun, but not completed, the immunisation series had stopped for differing reasons. Some felt they had done enough to ensure their children were protected. These parents may have become complacent and we recommended they needed reminding of the reasons behind the importance of completion of the schedule, along with positive reinforcement. Directing attention to this group with reminders and reasons for completing would likely be a relatively easy target.

A further group of parents had started immunising their children, but lost confidence in either the vaccines or the health providers and we call them ‘Low Confidence’, as shown in Figure 5.2. These parents could benefit from help to evaluate the risks and benefits of immunisation and the diseases. We suggested strategies, such as support and positive reinforcement via health professionals; this would likely require more intensive and more effective communication tools and resources.

A separate group among those who had not completed the immunisation series was the parents who appeared to have very little knowledge, understanding or awareness of the diseases and the vaccines protecting against them. These groups we called the ‘Unaware’, and were more likely to be from backgrounds of poverty and low educational achievement, hard to access and likely to require more intensive resources via outreach services. The final group was those that had actively chosen not to immunise, whom we called the ‘Conscientious Objectors’, as shown in Figure 5.2. These parents appeared committed to their belief system and it seemed unlikely that improved knowledge or communication strategies would affect their decisions. We recommended strategies to minimise the activities of the anti-immunisation lobby to reduce fears and myths spreading for other parents, especially those who felt low in confidence about the immunisation decision, rather than directly targeting this group of parents.

Overall, we recommended focusing on strategies that include strong reassurance to parents around vaccine safety, information with reasoned scientific rationale and cues for safety, such as showing healthy immunised infants. Alongside this, reinforcement of the gains of immunising behaviour to reduce dissonance, but also to ensure parents who have immunised feel positively reinforced towards their decision.

We saw it as important to recognise the role of whānau in Māori parental decision-making and therefore to link the immunisation messages to the family group in a way that does not create blame or guilt. We recommended a focus on messages using children as the centre of the family and stressing the value of children’s wellness for the whole family.

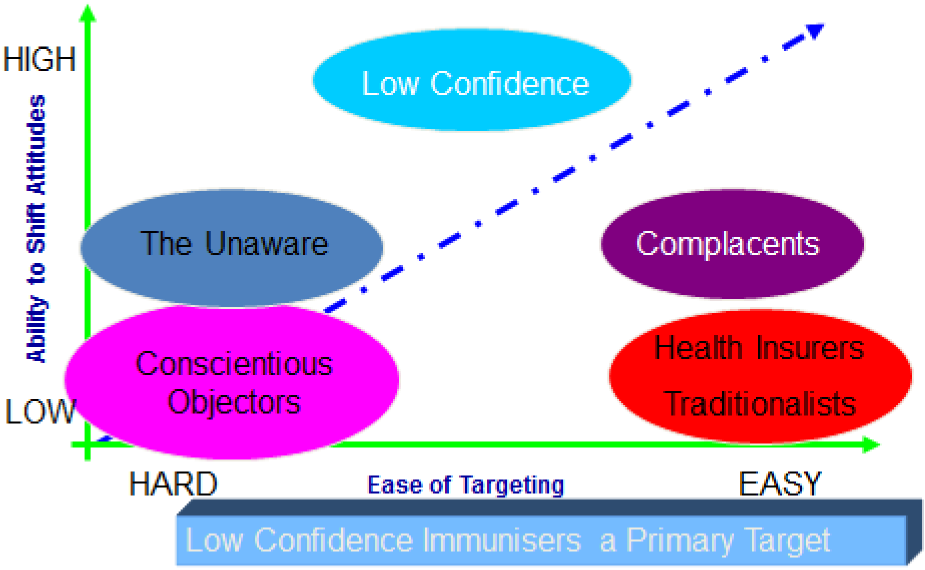

Figure 5.2: Recommended strategies for targeting different parent groups

5.6 Parental concerns identified via a national telephone line

5.6.1 Background

As part of the IMAC strategy to support both parents and healthcare providers by offering timely and accurate information and an avenue to support parental decision-making processes, IMAC established a free phone line, funded by the MoH. It was initially a service for only the Auckland region in 1997, then became a national toll-free line in 1998, offering advice to the public and HCPs. This phone line collected data on all calls made and gave us the opportunity to explore and analyse the type and nature of enquiries. Utilising the internal resources of IMAC, the Department of General Practice and Primary Care and the HRC summer student fund we chose to undertake a comparative analysis of data collected by the hotline call centre over two periods, 1999 and 2003. The planning team involved Helen Petousis-Harris, Felicity Goodyear-Smith and myself. Most of the research and analysis was undertaken by Stephen Ram, who was working on the summer studentship. The call centre team consisting of Natalie Desmond, Heatherbel Eyre, Elaine Boyd, and Jane Millard supported the research. The results were published in 2005 (18). The aim of the study was to conduct both quantitative and qualitative analysis of data collected by the national phone line and compare and contrast the two periods of time.

5.6.2 Methods

Data recorded on all phone calls made to the 0800 phone line from 1 January to 10 November 2000 and from 1 January to 10 November 2003 were entered into a Microsoft access database. The phone-line operations regularly entered data on all callers, including anonymous data on the caller profile: gender, description of the type of caller (e.g. parent, PN, GP), designation (e.g. father), region of call and the content of the enquiry. This data also includes qualitative information around the content of the enquiry. A triangulation method was used for analysis. For quantitative data calls were classified and coded under categories to determine the caller profile, which included type of caller, nature of enquiry, subject (allowing up to five subjects per enquiry) and operator response to the enquiry. Statistical analysis was undertaken using the chi-square test and p-value to analyse for significance. For the qualitative analysis, a general inductive approach was used to analyse free text responses in the call transcripts to identify major themes. Because there was a large quantity of data, all call transcripts were selected from just one operator for both years. The operator chosen was highly experienced, had consistently good record entering, worked a variety of shifts and had minimal absenteeism over these periods. Calls were separated into HCP and public and analysed for sub-themes in the different groups. These were combined into major themes after discussion between the research team and independently coded. Any discrepancies were resolved by adjudication.

5.6.3 Results

Results pertinent to the public calls are presented here. HCP results will be discussed in Chapter 7.
Caller numbers from the public were 627 in 1999 and 1507 in 2003. The type of calls consisted of 75% (421/627) from parents, 5.5% (35/627) from students and 19% (121/627) from other members of the public in 1999. For 2003, 73% (1100/1507) were from parents, 1% (17/157) from students and 26% (390/1507) from other members of the public. Table 5.4 which is adapted from Petousis-Harris et al (13) lists the most common reason for calls.

In both years, there was a small number of calls reflecting an actively anti-immunisation stance: The combined HCP and general public calls in 1999 having 18/1007 (2%), and in 2003 16/3446 (0.5%) of calls defined as having anti-immunisation sentiment. Furthermore 133/1007 (13%) in 1999 and 116/3446 (3%) in 2003 were defined as having ambivalence or concerns about immunisation safety. There was a significant reduction in these anti and ambivalent attitudes from 1999 to 2003 (p<0.0001).

Table 5.4: Nature of the calls to the phone line from the public

Reason for call	1999 n (%) Tot = 724	2003 n (%) Tot = 2095	χ^2 (d.f. = 1)	p
Information on DTaP	152 (21)	179 (8.5)	80.5	<0.0001
Catch-up schedules	22 (3)	141 (7)	13.5	0.0002
Information on MMR	99 (14)	329 (16)	1.7	0.2
Information on other vaccines and immunisation-related services	275 (38)	1164 (56)		
Other/not identified	176 (24)	282 (13)		

Common themes are listed in Table 5.5 which is adapted from Petousis-Harris et al 2005 (18). Parental fears/concern/misinformation was a major sub-theme. In 1999, 'new vaccines' were prominent with the introduction of the acellular pertussis-containing vaccine and the imminent change to inactivated polio vaccine from OPV. Other common themes were schedule enquiries, MMR, specific vaccine or disease information, general information, attitudes to immunisation, AEFIs and special risk enquiries. Catch-ups, international integration, splitting, and schedule vaccine enquiries were common in both 1999 and 2003. In 2003, premature baby enquiries were also featured as a sub-theme. MMR enquiries were dominated by splitting the vaccine, autism and Crohns in both years. Egg allergies were noted in 1999 and infectiousness of the vaccine in 2003. Chicken pox exposure was an important sub-theme of the ‘special risk’ category in 2003.

Table 5.5: Themes and subthemes from public calls with examples

Theme • **subtheme**	**Example**
Schedule enquiries • Catch ups	*I cannot get Plunket and my son is a 3-month old and has not been vaccinated. He needs it. Please, can you help me?*
• International integration	*A child from part of Russia has been given a form from school to get polio and Td. I am not sure what she needs?*
• Premature baby	*Baby is in PICU and is 6 weeks old. They want to vaccinate him. He is under 2 kg, and some friends say I should not vaccinate him.*
• Splitting vaccines	*I am wondering if it is ok to leave out the pertussis part of the baby vaccinations.*
• Schedule vaccines	*Which vaccines have mercury in them?*
MMR • Splitting	*Explained why there weren’t the single vaccines; mother then wanted to know how she could import the single vaccines?*
• Egg allergy	*The MMR- is it in an egg base and what reaction could I expect if my child is allergic to egg?*
• Autism/Crohns	*My son is autistic and the craniologist said that in either America or England they have linked it to MMR vaccination.*
Infectiousness of vaccine	*I have been in contact with a child that had MMR…can I catch anything?*
Specific vaccine/disease information	
• Acellular pertussis	*Do we have acellular vaccine in NZ?*
• Travel	*I am going to Thailand in 2 weeks and I am wondering what vaccination I will need?*
• Other	*Mother was a pre-school teacher and there had been a case of rubella at the centre. She is 12 weeks pregnant.*
Attitude	
• Pro	*Saw IMAC Director on TV, Wants to volunteer her services to help our cause!*
• Ambivalent/anti	*I am a grandmother. I am against vaccination; I do not want my daughter to vaccinate my little granddaughter.*
AEFI	*This child had MMR at 15 months and had urticarial, breathing problems and needed two injections by the nurse to come right.*
Special risk query • Chicken pox exposure	*My grandson has chicken pox. My GP said I should not mind him as I might get shingles.*
General	*I have ankylosing spondylitis, so do I get the flu vaccine free?*

5.6.4 Conclusions

A range of issues affect the environment of perception and knowledge among the public. Of note, from this study were changes to the immunisation schedule, emerging international research and media activities. This study showed important changes in caller profile from 1999 to 2003, with enquiries shifting from the pertussis-containing vaccines to MMR, reflecting the international moves from concerns over whole cell pertussis-containing vaccines to MMR safety. Some of the sub-themes here are consistent with our earlier research around fear and lack of knowledge. This study highlighted a number of misconceptions, particularly around the MMR vaccine, such as seen with the queries around wanting to split the vaccine and inaccuracies over egg allergies. A strength of this study was the self-initiated nature of the callers with sufficient concerns to seek advice. However, it may not be representative of the general population and bias is likely to be towards callers with access to a phone and the knowledge and confidence to access a call centre. Lower income New Zealanders are likely to be underrepresented.

5.7 The antenatal period and decision-making

5.7.1 Background

An important finding from our research was the emotional challenges parents identified in their desire to make an active decision around whether to choose to vaccinate their infant or not (195). It seemed clear that the antenatal period was a particularly important time for parents, when they become aware of and engaged in, thinking around the childhood immunisation programme for their future infant. Our research had identified themes around fear expressed with words such as finding the decision-making a ‘burden’ and feeling ‘conflicted’ (9). Alongside this, there was an expressed lack of knowledge around the childhood vaccines and the diseases, a desire for more information, and concerns expressed that LMCs were not providing adequate information or offering confused or conflicting information (10). The changes in purchasing of antenatal services in 1996 meant that the majority of pregnant women from that time onwards had little, if any, contact with the general practice team in the antenatal period. The LMC, who is usually a midwife or an obstetrician, was not traditionally involved in immunisation delivery services. A NZ study undertaken on health providers in Rotorua, published in 2004, showed significant gaps in LMC’s knowledge and confidence in immunisation, midwives in particular (185). The other avenue for parents to be informed antenatally is via antenatal classes, which were delivered by a wide range of providers from a range of backgrounds, with no requirements to include teaching around immunisation in these classes. Recognising these issues, and working closely with my colleague Helen Petousis-Harris, we chose to undertake further research, focusing particularly on mothers in the antenatal period.

Immunisation information offered in antenatal education classes

The next research we undertook was to gain more knowledge on what information parents received, or what they perceived they received in the antenatal period (11). We undertook a small survey of parents specifically to identify what literature they recalled receiving via antenatal education classes. The Principal Investigator was my colleague and co-collaborator at IMAC Helen Petousis-Harris and I utilised IMAC funding and internal resources to fund it. Elaine Boyd, an experienced nurse specialist working for IMAC, was the researcher who undertook the data collection.

5.7.2 Methods

The design used a telephone questionnaire. Participants were recruited from parents who had attended antenatal classes through any provider in the Auckland region and were attending a tour of the maternity unit at National Women's Hospital, the main public maternity hospital for Central Auckland. Tours were held three times a week and parents expecting to deliver at this unit were invited to attend and talk about the facilities. At a convenient point during the tour, the nurse educator leading the tour introduced the researcher (Elaine Boyd) and gave her the opportunity to speak to the attendees. Elaine invited participants to consent to a short telephone survey about the nature of immunisation information received during their antenatal classes. Consenting parents were followed up with a telephone call within a month. The questionnaire was brief and consisted of questions asking what information was received, whether it was enough to feel they could make a decision, whether it was positive, negative or neutral, the likelihood that they would immunise their infant, and some demographics.

5.7.3 Results

Class sizes varied from 6 to 20 and included partners/support persons. Over nine visits, 45 participants were recruited. There were one to two decliners per group. Five of those recruited were unable to complete the interview process due to early hospital admission (1) and limited English (4).

Thirty one (77.5%) of the respondents were NZ European, two (5%) Māori, seven (18%) Pacific, Asian, Indian or UK European. All were ages 20 to 40 years. Eight (20%) had a GP obstetrician, four (10%) a hospital midwife, 21 (53%) an independent midwife, and seven (18%) a specialist obstetrician as the LMC. Antenatal class providers varied with 10 attending Birthcare, 13 National Women's and 13 attending four different Parent Centre classes in the region.

Thirty four (75%) recalled receiving immunisation information during antenatal classes. Twenty four (60%) received both written and verbal information, and ten written information only. Of those who received written information, ten did not recall what they were given, eight were given MoH pamphlets only, one was given only the anti-immunisation pamphlet produced by the Immunisation Awareness Society, six were given both the MoH and the Immunisation Awareness Society pamphlets, and a further eight were given a mixture of other material. Overall 19 (48%) felt that they had been given adequate information about immunisation to make an informed choice, 21 (52%) felt they had not enough information to make a decision. Twelve (30%) felt the information received was only positive towards immunisation, 21(53%) felt the information was neutral and no one felt the information was only negative towards immunisation. Participants ranked their likelihood of immunising their babies on a 5 point Likert scale from not at all to very likely. One respondent replied 2, four replied 3, ten replied 4, and 25 (63%) replied 5, i.e. very likely. Although 63% of participants stated they were very likely to immunise their infant, only 33% were very confident about their decision ($p=0.014$).

5.7.4 Conclusions

This was a small study and the results may not be generalisable to other regions and population groups. The study did not have sufficient numbers to compare ethnic or age differences and was limited to English-speaking mothers with a telephone. The major findings of concern were that a quarter of parents appeared not to have received any information at all. Of those who did, a sizeable minority received anti-immunisation information. Over half of those surveyed did not feel they had been given adequate information to make a decision, and even for those who did feel they were likely to immunise, there was a difference between the likelihood of immunising and their level of confidence. We called for further focus and resources on the antenatal period to improve information and resources to expectant parents.

Later research we undertook substantiated these findings and came from one arm of a larger study we undertook in 2004 around the determinants of immunisation coverage at the general practice. This study methodology is described in Chapter 7.2.2. As part of the larger study, we undertook a telephone survey on 957 randomly-selected caregivers of children under 2 years of age (refer Figure 7.3) with a median of 8 caregivers selected per practice. The findings showed that the majority of mothers (67%) made their decision regarding immunisation while they were pregnant, only 62% of caregivers reported having received immunisation information in the antenatal period and 29% reported receiving information that discouraged them from immunising their children (25). Caregiver receipt of discouraging information antenatally was associated with lower immunisation coverage in the practice (67% versus 73% $p = 0.03$).

5.8 Understanding parental decisions about early childhood immunisation

5.8.1 Background

The small antenatal study highlighted again significant concerns for parents with their decision-making processes in this period of time. I was fortunate to make contact with Dr Abigail Wroe, at this time an academic psychologist funded to undertake post-graduate research on a Welcome Trust grant. Abigail shared my interest in the parental decision-making and we worked together to design two studies. The first study aimed to investigate the factors that influence actual decisions about whether or not to opt for childhood immunisations. This included investigating maternal reasons for and against immunising, how the balance is associated with the likelihood of immunising and the influence of emotional factors. Dr Paul Salkowskis from the institute of Psychology, Kings College London was also involved in advising on the design and writing the manuscript for this first study.

5.8.2 Results

This was a longitudinal study of pregnant/early postpartum women. Pregnant women were recruited through LMCs to participate. The main LMCs, GPs, midwives and obstetricians who worked at the major central Auckland maternity hospital, National Women's, were approached by telephone. Those who agreed to help with recruitment were sent flyers, response sheets and postage paid envelopes. These were to be given to clients in their third trimester of pregnancy to whom the LMC had already mentioned immunisation. Respondents were then telephoned, given more information about the research, invited to take part and sent the questionnaire with a postage paid envelope. The questionnaire was divided into four main sections:

1. Section one asked participants how likely they would be to immunise their child, how they viewed the information they had received about advantages and disadvantages of immunisation, and what their preferences were regarding immunisation.

2. Section two was an open-ended question asking participants to state all their reasons for and against immunising their children. They were also asked to rate each reason on a scale from 0 being not relevant at all to 100 being extremely relevant.
3. Section three asked about the six diseases against which the primary immunisation course is used (diphtheria, tetanus, pertussis, polio, hepatitis B, and haemophilus influenza type b), and they were asked to rate how likely they thought their child would develop each disease, if immunised or if not immunised and if no children in the community were immunised. They were then asked to rate how harmful they thought the disease would be for their child on a 0 to 100 scale, how responsible they would feel for what happened with 0 being not responsible at all to 100 being totally responsible, and finally how much they thought they would regret not immunising on a scale of 0 being no regret to 100 being total regret.
4. Section four asked about effects that are sometimes related to immunisations: soreness, redness or injection site swelling, persistent crying for more than 3 hours, mild fever, high fever, not eating properly or vomiting, drowsiness, sleeping less than usual or restlessness, temporary cyanosis (described as bluish discoloration of the skin), shock-collapse - all with full recovery and more serious issues - long–term seizures, brain damage, anaphylaxis (described), paralysis,and sudden infant death (cot death). A statement was included at the end of this section to reassure participants that there is no scientific evidence that immunisations cause brain damage, long-term seizures or cot death and there is a very low risk of between 1 in 1 million and 1 in 10 million of a child developing paralytic polio from the OPV. For each event, participants were asked how likely they thought the event would be to occur with 0 being no change to 100 being definitely happening, how harmful they thought it would be for their child, how responsible they would feel, and how much they would regret not immunising, all on a scale of 0 to 100.

They were re-contacted when the infant was eight to ten weeks of age and asked whether the baby was immunised, and if so when the immunisation had occurred, and when they had made the decision.

Statistical analysis of emotional factors

Three variables were calculated as scores of perceptions of physical risk and benefits and four variables were calculated as scores of emotional or omission bias factors.

1. The perceived individual benefit of the immunisation was calculated for each disease as the difference between the perceived risks of developing the disease if the child was not immunised, versus the perceived risk of developing the disease if the child was immunised. The product of this score and perceived harm the disease would cause if the child were to develop the disease was calculated. A total score for all six diseases was calculated for each individual.
2. The perceived community benefits of the immunisation were calculated as the difference between the perceived risk of developing the disease if no children were immunised, and the perceived risk of developing the disease if the child was immunised. The product of this score and perceived harm of the disease was calculated. A total score for all six diseases was then calculated for each individual.
3. The perceived risk of the immunisation was calculated as the product of the perceived risk of each possible adverse effect.
4. The perceived harm to the child if the adverse effect did occur.

The total score for all adverse effects was calculated to obtain the final score.

Omission bias was calculated by the total score for all six diseases of the feelings of responsibility if harm occurs after inaction (omission). Commission (feelings of responsibility if harm occurs after action) was the total score for all adverse events if the child was immunised. Omission (anticipated regret if harm occurs after inaction) was the total score for all six disease of anticipated feeling of regret if the child then developed the disease.

5.8.3 Results

Of the 83 LMCs contacted, 50 agreed to engage with recruitment for the study. From a total of 427 flyers sent to LMCs to give to clients, 235 (55%) completed response sheets were returned to the researcher. All 235 were telephoned and sent the questionnaire and 195 (85%) completed and returned the questionnaire.

Of the 195 participants, the average age was 32.7 years; 49 (25%) had no further education after leaving school, 173 (89%) were with a partner, 98 (50%) were having their first child, 150 (77%) were NZ European origin, 18 (9%) Māori, 13(6.6%) Pacific, 5 (2.5%) Asian and 8 (4%) missing data.

Overall, 127 (67%) of participants stated that they definitely would immunise their child and 10 (5%) definitely not. Eighty six (44%) felt they did not have enough information (rating < 50 on the scale) and 72 (37%) felt they had the right amount of information. In terms of decision-making, 10 (5%) would prefer the healthcare professional to make the decision alone, 20 (10%) would prefer the healthcare professional to mostly make the decision, 71 (36%) to be equal shared decision-making, and 84 (43%) to have more of the decision-making themselves than the healthcare professional, of whom 31 (16%) wished to make the full decision alone.

Postnatally, three mothers could not be contacted and one mother was not contacted as she had had a stillbirth. Of the 14 participants (7%) who rated below 50 on the likelihood of immunisation, all decided not to immunise; of the 6 (3%) who rated 50 on the scale, two (1%) had immunised and four (2%) had not; of the 171 who rated above 50 on the scale, 146 (85%) had vaccinated on time, 16 (9%) late (after two weeks), 7 (4%) did not immunise and a further two did not immunise due to genuine contraindications through severe ill health of the child. There was a strong association between individuals' antenatal rating of likelihood of immunising and their actual decision (p=0.87) with a 97% accordance based on the antenatal decision. Overall, 166 (88%) of participants made their decision antenatally.

On average, participants stated 2.7 reasons for and 1.8 reasons against immunising their infant. The reasons were categorised into 12 pros and 18 cons. See Table 5.6 and Table 5.7 below which are reproduced from Wroe et al 2004 (19).

Table 5.6: Reasons for Immunising the child and frequency with which they were stated

Reason	% all participants (n=195)	% participants who immunised on time (n=148)	% participants who immunised late (n=16)	% participants who did not immunise (n=25)
To protect my child against these diseases	10	79	93	64
Community/society benefits	42	43	44	35
General health	18	20	25	8
Low risk of the immunisation or low risks compared to benefits	14	16	0	4
To allow/help with entry into childcare centre/schools	13	13	25	12
Family values or general attitude	13	15	13	8
High prevalence of the diseases	11	11	0	20
Emotional reasons e.g. guilt	10	12	6	4
High severity of the diseases	9	11	0	0
Advice from health professionals	7	7	13	4
Social pressure	4	3	0	12
Low barriers to immunisation	4	5	0	0

NB data are percentages of participants stating each reason. There were no significant differences for any reason category between the groups (p >0.06)

Table 5.7: Reasons against immunising the child and frequency with which they were stated

Reason	% all participants (n=195)	% participants who immunised on time (n=148)	% participants who immunised late (n=16)	% participants who did not immunise (n=25)
Side effects (or potential) of the immunisations	63	62	63	72
Pain or distress or injection	12	11	19	12
Preference for “natural immunity’	10	4	6	48*
Mistrust of information from drug companies or government	10	6	6	36*
Child too young	8	5	6	28*
Emotional reasons	5	1	6	24*
Immunisations are not effective	5	3	0	20*
Possibility of catching the disease from the immunisations	4	4	6	4
Low risk of catching the disease	4	2	0	4*
Putting foreign bodies/germs into the infant	4	1	0	4
Low severity or treatability of the diseases	3	0	0	24*
Mistrust of the manufacturing process	3	1	0	16*
Ingredients of the immunisations	3	1	0	16*
High doses of immunisations	3	1	4	8
Aversion to drugs	2	0	4	12
Possibility of the diseases becoming resistant to the immunisations	2	3	0	0
Having read anti-immunisation information	2	3	0	0
Barriers to immunisation	1	1	0	0

NB Data are percentages of participants stating each reason. Significant differences are marked with asterisks.

Decisions balance was calculated as the difference between the pros and cons divided by the total of the pros and cons. The decision balance was highly correlated with antenatal rating of the likelihood of immunising the infant ($p>0.01$), such that individuals who were more likely to immunise rated a higher relevance of pros compared with cons.

Participants who immunised their children perceived the diseases as significantly more harmful than those who did not immunise their children (independent t (187) >3.90, $p>0.01$). Perceived risk of adverse events was rated lower by the immunisers than the non-immunisers (t (187) >2.80, $p<0.01$) for all adverse events except long-term seizures, brain damage and cot death.

Immunisers had higher ratings of perceived personal benefit of the immunisation (t (187) =8.52, $p<0.01$); higher ratings of perceived community benefit (t (187) =7.63, $p<0.01$) and lower ratings of perceived risk (t (187) =9.21, $p<0.01$). Immunisers had higher ratings of anticipated responsibility of harm after inaction (t (197) =10.23, $p<0.01$), higher ratings of anticipated regret if harm occurred after inaction (t (197) = 12.69, $p<0.01$); lower ratings of anticipated responsibility of harm after action (t (1870 = -9.21, $p<0.01$) and lower ratings of anticipated regret if harm occurred after action, (t (187) = -8.94, $p<0.01$).

Anticipated regret, if harm occurred after inaction, was the strongest predictor of likelihood of immunising the children (predicted 47% of the variance; adjusted R^2 =0.47, $p <0.01$). This was followed by anticipated regret if harm occurred after action, feelings of responsibility if harm occurred after inaction, feelings of responsibility if harm occurs after action, personal benefits of immunisation, risk of the immunisation and education level. Variables that were not entered were demographics (age, relationship status, first child or not, ethnicity) and perceived community benefit of the immunisations.

In order to more closely investigate variance explained by omission bias factors, we conducted hierarchical regression analyses, Demographics were forced into Step 1, perceptions of physical risk and benefits forced into Step 2 and omission bias factors were allowed to enter in Step 3. Demographic variables were found to predict 15 of the variance (R^2 = 0.05, adjusted R^2 = 0.02, p = 0.18), perceptions of physical risk and benefits predicted a further 42% of the variance (change in adjusted R^2 = 0.42, $p<0.01$) and the omission bias factors predicted a further 25% of the variance (change in adjusted R^2 =0.25, $p<0.01$). The majority of the variance explained by perceptions of physical risks and benefits was in personal benefits of immunisation and risks of immunisation. Omission bias factors were explained by anticipated regret if harm occurred after inaction and anticipated responsibility of harm after action.

5.8.4 Conclusions

There were some limitations of this study. It was only undertaken with women and no account was taken of the role of fathers and other partners or wider family members, such as grandparents, in the decision-making. There is no knowledge of those LMCs and those mothers who declined to participate. Thirdly, it is not possible to know whether the beliefs were the prime cause of the decision or rationalisations of the decisions they made. However, individuals’ responses were obtained before the final decision was made.

Our findings were consistent with the notion that individuals reach their decisions by weighing the perceived pros and cons that they see as relevant. The association between prediction of the decision and the eventual decision made was extremely strong.

The decision was strongly influenced by emotional factors, and this was independent of objective factors. Therefore, we concluded that omission bias does seem to play a major role in the decision on whether to immunise infants. Non-immunisers had higher ratings of anticipated responsibility for harm that occurs following action (immunisation) and greater anticipated regret of that action. Regression analyses suggest that emotional factors were a better predictor of the likelihood of immunisation than reasons based on physical risk and benefits.

5.8.5 Recommendations

We recommended that certain beliefs about immunisation and immunity, in particular the preference to keep the immunise system ‘natural’ and that infants are too young to be vaccinated, be directly addressed in the information provided by the health professional. We highlighted the concern that 10% of participants stated that they did not trust the information provided, and this was more commonly expressed by non-immunisers.
We particularly recommended that, because the majority of decisions are made in the antenatal period, parents be given more support antenatally and we recommended interventions to aid decision-making in this period. We stressed the importance of recognising omission bias in decision-making, i.e. that people tend to be more concerned about things that go wrong because of what they decide to do, rather than because of things they decide not to do and having this as a focus in any decision-making tool. One way of doing this would be to focus on immunisation as the norm, so non-immunising would be more of an active decision than immunising.

5.9 Evaluating a decision-making aid for parents regarding childhood immunisations

5.9.1 Background

The second study working with Dr Wroe involved piloting a decision-making aid to support parents in their decision around childhood immunisation, including measuring their satisfaction and confidence in their decision. Dr R Glynn Owens from the Department of Psychology, University of Auckland was also involved in the design, planning, analysing and manuscript writing of this study.

Following our recommendations from the first piece of research, we chose to develop a decision-making aid for parents to use in the antenatal period. Based on our findings from the research above, we designed an intervention tool that included the following three factors:

I. The provision of more detailed information on benefits and risk of immunisation according to the scientific evidence.
II. Information on the possible role of emotional factors.
III. The ‘focusing procedure’ which encourages individuals to focus on the relevant, and scientifically valid, issues.

We hypothesised that the intervention would be associated with an increase in the likelihood of immunisation; an increase in an individual’s perceptions of the benefits of immunising, a reduction in perceptions of risks, reduction in anxiety and overall increased satisfaction with the decision to immunise their infant.

5.9.2 Methods

Women attending antenatal education classes at National Women's Hospital, the major central Auckland hospital for maternity services, were invited to take part in research. The research was an RCT with the intervention involving a mailed questionnaire followed by a telephone interview. See Figure 5.3 replicated from Wroe et al 2005 (20) for an outline of the methodology.

A sample size of 100 was chosen to permit 80% confidence of detection of a difference of 0.75 standard deviations between the ratings of likelihood of immunising and long-term satisfaction with the decision, assuming a significance level of 0.01.

There were three time points:

I. Time point one (pre-intervention): Prior to the intervention and involving a structured telephone interview.
II. Time point two (post-mailed out information): A face-to-face interview following the posting of the intervention tool booklet to those randomised to the intervention arm and the MoH standard booklet to those randomised to the control arm. This included focusing questions for the intervention group.
III. Time point three (post intervention): A structured telephone interview.

Following this, there was a follow-up telephone call when the infant was 8 to 10 weeks of age.

In order to prevent contamination, cluster randomisation was undertaken via antenatal classes, not individuals, with alternating classes being assigned to intervention or control. There were 7-11 pregnant women per class. Those recruited from the final class (n=7) were allocated according to initial rating of their 'likelihood of immunising' in order to balance the groups in terms of baseline differences in decision ratings. Across-group contamination was avoided in these women because the post intervention ratings were undertaken prior to their next antenatal class, i.e. before they met one another again.

The pre-intervention questionnaire was posted to all participants and they were asked to open it during a structured telephone interview at time point one. This covered three areas: the likelihood of immunising and anxiety, the perceived risk and harmfulness of the diseases, and the perceived risk and harmfulness of adverse effects that are often related to the vaccines. The intervention group was then sent a 20-page booklet that covered detailed information about the benefits and risk of each of the immunisations, and a one page section on issues related to psychological aspects of omission bias. The control group was sent the less in-depth standard 19 page leaflet published by the MoH titled "Immunisation Choices" (Ministry of Health 2001). This leaflet comprised sections on how does immunisation work; the immunisation certificate; questions about immunisation; the nine diseases immunisation addresses; and what are the risks of immunisation. Several days later, a face-to-face interview was undertaken to rate the satisfaction, the clarity, quantity, and usefulness of the information. Individuals in the intervention group were also asked some focusing questions such as:

If my child was immunised:

> *I would feel glad that I had done my best to prevent my child from developing these serious illnesses.*

> *I would know that there is a chance (up to 1 in 10) of my child having an unusual high-pitched cry; this would be very unpleasant and worrying at the time, but would almost definitely stop after a few hours.*

If my child were not immunised:

> *I would worry about him/her mixing with other children and adults who might be carrying diseases.*

To match the time spent interacting with the researcher, the interviewer asked individuals in the control group questions on the presentation of the information, such as its layout and colour.

Following the intervention all participants were asked to rate the time point one items again, as well as how prepared they felt for the effects of the immunisation, and to complete a validated satisfaction with decision scale (199). A follow up telephone interview was conducted when the infant was eight to 10 weeks of age.

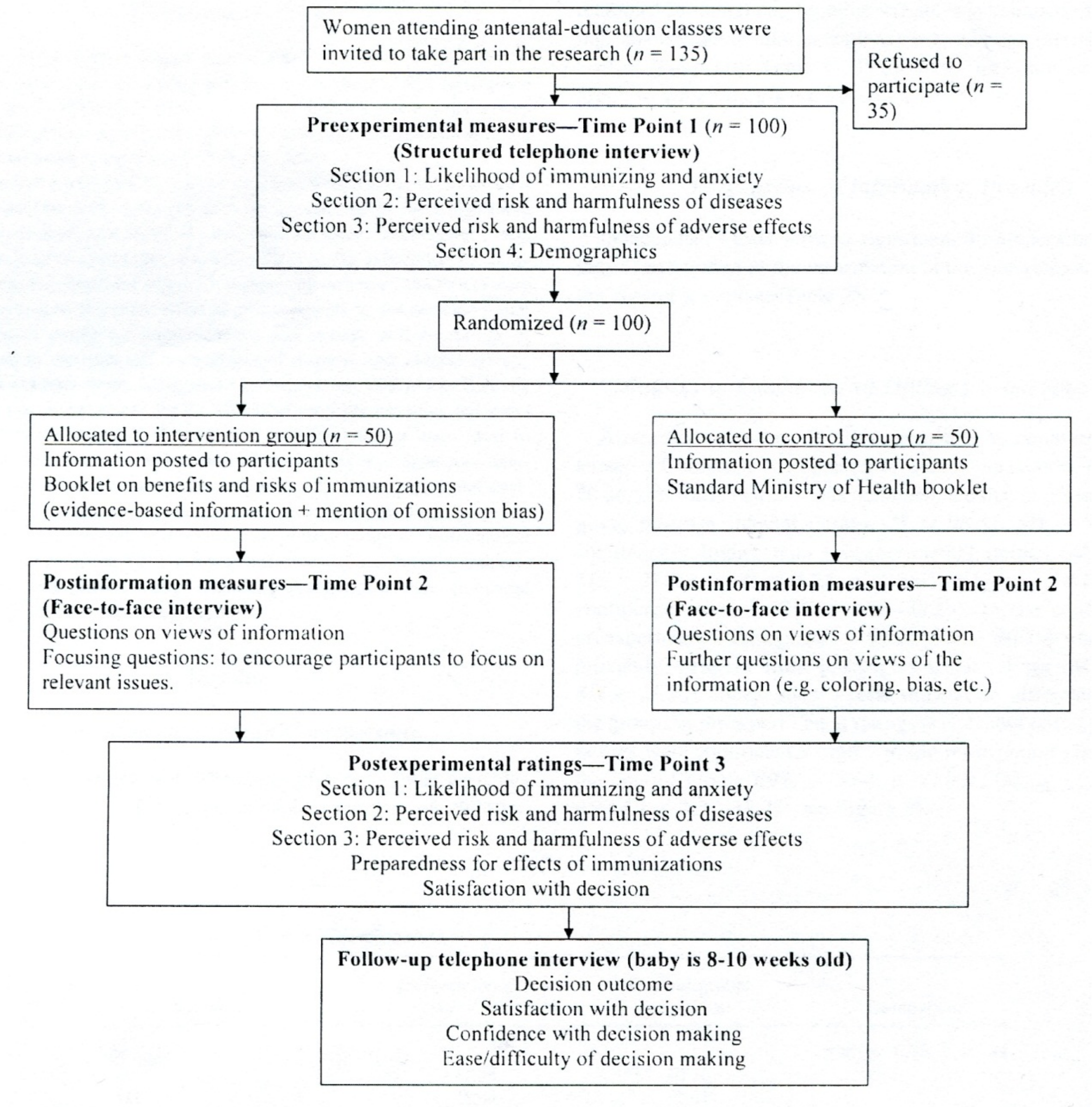
Women attending antenatal-education classes were invited to take part in the research (n = 135)
Refused to participate (n = 35)
Preexperimental measures—Time Point 1 (n = 100)
(Structured telephone interview)
Section 1: Likelihood of immunizing and anxiety
Section 2: Perceived risk and harmfulness of diseases
Section 3: Perceived risk and harmfulness of adverse effects
Section 4: Demographics
Randomized (n = 100)
Allocated to intervention group (n = 50)
Information posted to participants
Booklet on benefits and risks of immunizations (evidence-based information + mention of omission bias)
Allocated to control group (n = 50)
Information posted to participants
Standard Ministry of Health booklet
Postinformation measures—Time Point 2
(Face-to-face interview)
Questions on views of information
Focusing questions: to encourage participants to focus on relevant issues.
Postinformation measures—Time Point 2
(Face-to-face interview)
Questions on views of information
Further questions on views of the information (e.g. coloring, bias, etc.)
Postexperimental ratings—Time Point 3
Section 1: Likelihood of immunizing and anxiety
Section 2: Perceived risk and harmfulness of diseases
Section 3: Perceived risk and harmfulness of adverse effects
Preparedness for effects of immunizations
Satisfaction with decision
Follow-up telephone interview (baby is 8-10 weeks old)
Decision outcome
Satisfaction with decision
Confidence with decision making
Ease/difficulty of decision making

Figure 5.3: Study design for the antenatal decision-making aid

5.9.3 Results

One hundred and thirty-five women were invited to participate, of whom 100 (74%) consented. One did not complete because she felt the information booklet was biased, but she did complete the follow-up telephone interview.
There were no significant differences in demographic variables (age, highest educational level, ethnicity, number of children, relationship status) and baseline variables (likelihood of immunising, anxiety about immunisations) between the intervention and control group.

There were significant differences between the rating of perception of the information in the intervention group and the control group.

This was a clustered design analysis, but we did not undertake weighting to adjust for intra-antenatal class correlation, because the biostatistical advice was that this was unlikely to make any real difference to the outcomes.

Psychological variables
Independent t-tests demonstrated that the intervention group, compared to the control group, had significantly higher ratings of both ‘preparedness for the effects of the immunisation’ (t [97] =6.16, p<0.001, mean difference 21.54, 95% CI 14.58 to 28.49); and ‘Satisfaction with the Decision’ (t [97] =6.05, p<0.001, mean difference 4.56, 95%CI 3.06 to 6.05).

Follow-up measures
Of the 90 participants who gave antenatal, post-intervention ratings on the decision scale of above or below 50 on the decision rating scale, 86 (96%) made a decision as would be expected. In the intervention group, 45 (90%) immunised on time (before the child was eight weeks old), two (4%) late (aged 8-12 weeks), and three (6%) did not immunise (by age 3 months). In the control group, 35 (70%) immunised on time, six (12%) late and nine (18%) did not immunise (χ^2 [2] =6.25, p<0.05). This difference was due to a significantly higher proportion of individuals in the intervention group immunising on time, as opposed to late or not at all (χ^2[1]=6.25, p<0.05). The proportion of participants in each group who immunised compared to those who did not immunise at all, did not reach significance (χ^2 [1] =3.41, p=0.07).

Follow-up measures of satisfaction with decision were significantly higher in the intervention group than the control group (t [98] =4.54, p<0.001, mean difference 2.65, 95%CI 1.49 to 3.81). The intervention group compared to the control group had lower ratings of anxiety (t[98]=-3.07, p<0.01 mean difference 18.34, 95%CI 6.47 to 30.22); had higher ratings of confidence in making the decision (t[98]=2.32, p<0.05, mean difference 9.04, 95%CI 1.30 to 16.78); and perceived the decision as less difficult (t[98]=2.55, p<0.05, mean difference 17.73, 95%CI 3.91 to 31.54).

5.9.4 Conclusions

Participants’ actual decisions whether to immunise their infants were strongly predicted by the antenatal ratings of ‘likelihood of immunising’. The intervention package successfully reduced maternal anxiety and improved maternal satisfaction with the decision. This also translated into action with mothers being significantly more likely to immunise on time. This contrasts with concerns expressed that providing information on the adverse effect of immunisation may increase anxiety and decrease uptake. We felt that the changes in perception of risk and harmfulness of the adverse effects mediated the change in immunisation decisions.

Limitations of this study included the small sample size, lack of long-term follow-up, randomisation by antenatal classes that may have created group bias in participants, recruitment through parents who attend antenatal classes with no information on the differences for parents who do not attend antenatal classes, and the degree of literacy required in English to understand the intervention booklet.

This study does not answer which of the three main ways the intervention differed from the control procedure and which had the most effect (the level of detail of information, an explanation of omission bias and the focusing intervention). We recommended that this study could be used as a first step to considering further development in decision aids suitable for healthcare settings.

5.10 Chapter conclusions

Historical concerns have been identified in the 1990s concerning policy decisions that affect which health care professionals engage with parents antenatally and in the first immunisation visit at the six-week Well Child visit. My earliest research showed that the six-week immunisation event was lower when not delivered within the traditional general practice setting. This policy decision was rectified, but does highlight the effect policy decisions can make on immunisation uptake.

One important factor contributing to immunisation uptake is the role of parents. Historically, NZ had very limited data on this issue, despite low immunisation coverage. This chapter presented research by myself and colleagues in this area that took a focus on parental knowledge, attitudes and beliefs and in particular, that of the mother.

NZ parents feel it is their role to make the decision around accepting or rejecting the immunisation programme for their child. Our research suggests that the majority of mothers wish to make the decision with the support of their health professional, either in equal partnership, or with the parent making the decision, but with supporting material and advice from the involved health care professional. Furthermore, the antenatal period is a vital time for parents to consider this issue, with almost all parents making their decision in this time period.

Decision-making in the antenatal period is strongly associated with resultant behaviour to immunise or not. Decision-making is also affected by emotional reasons, particularly anticipated responsibility for regret over action or inaction. Effective antenatal materials and decision-making tools result both in reduced parental anxiety and a positive outcome for immunisation. Recognising the role of omission bias in decision-making, that people tend to be more concerned about things that go wrong because of what they decide to do rather than because of things they decide not to do, effective decision-making tools appears to add to a positive outcome. We recommended, based on this, placing an emphasis on creating an environment where immunisation is the norm.

This is likely to lessen parental anxiety, reduce the effect of omission bias and support the making of a positive decision.

Our research consistently highlighted that parents wished to have more information around immunisation, found the decision-making often difficult and for many, this created a lot of anxiety. Some felt this was potentiated by lack of information, being given conflicting information, feeling there was a lack of support in decision-making, low confidence or trust in their healthcare professional's advice, or, for some, there were larger concerns around lack of trust in the NZ authorities and suspicion towards the role of the pharmaceutical industry in potentially biasing information.

A significant theme emerging for mothers was fear of immunisation. Firstly, the actual immunisation event and how painful and distressing it could be perceived was expressed as a barrier for more than a quarter of mothers, possibly even higher with mothers from Māori and Pacific ethnicity. Secondly there were expressed fears regarding possible vaccine adverse effects. These concerns may have been more prominent with older NZ European mothers. Alongside this, many parents perceived the vaccines to be ineffective and/or unnecessary and the diseases less relevant to their lives. A theme for many was a belief that *natural is best;* a sense that the best way to build an infant's immune system is via good healthy living - vaccines are somehow artificial and may not enhance the natural approach. Allied to this was a belief that infants' immune systems were too young to cope with vaccines. With over 40% of mothers feeling their infants were too young to start immunisation at the scheduled ages, around one in eight mothers believing vaccines were not effective and up to one in five believing good healthy living will prevent these disease, there was likely to be a significant minority of parents not convinced about the value of vaccines.

Parents can be grouped into different audience segments to assist with targeting more effective strategies and resources. We recommended that those that were currently accepting of vaccines (the t*raditionalists* and *health insurers*) be provided with positive reinforcement of their decisions and the importance of disease prevention, stressing wellness for the child and community; also recognising the broader whānau role, particularly with the Māori community. Those who were supportive, but incomplete, called the *complacents,* could be fairly easily targeted with regular precall and recall reminders and reducing missed opportunities to immunise. For those who lacked confidence we recommended more focus on effective information to support their decision-making, particularly the fear issues around vaccine safety, disease effects, and infants' immune systems. Then there was a group that are more likely to be facing access issues, called the *unaware*, who were more likely to be from low income backgrounds, possibly very young mothers with less education and likely to require more intensive support for access, outreach and support services. Finally, the *conscientious objectors* were unlikely to change their belief system, but strategies were needed to reduce the dissonance this group could create in others.

A significant limitation of this research was that it was almost exclusively undertaken with mothers. The role of fathers and the broader family decision-making processes remains to be explored. A further limitation was the lack of information on other important demographic groups, particularly ethnic groups such as Pacific and other immigrant groups.

This body of research raised a range of concerns around NZ parents' knowledge, attitudes and barriers in accepting the infant immunisation programme. I was in the privileged position of having many opportunities in my role in IMAC over these years to offer policy advice based on this research to the NZ MoH and DHBs, which was frequently acted upon.

5.11 Summary of Chapter 5

This chapter focused on the issues of parental knowledge and attitudes as a contributory factor associated with childhood immunisation coverage. It initially presents the NZ background prior to my engagement in this topic, followed by a discussion of the research I have undertaken and published with colleagues over the period from 1999 to 2005. This research has focused on the barriers to up taking childhood immunisation through the perspective of parents and, in particular, mothers. The research initially explored maternal knowledge and attitudes, then undertook more in-depth study to identify different patterns for particular groups of parents to enable the development of more directed strategies and resources to support the different parental group needs. From a better understanding of parental concerns, our research moved on to designing and implementing decision-making tools. This showed the ability to support parents in the antenatal period in positive decision-making for their infant and earlier uptake of childhood immunisation for the first event.

CHAPTER 6 OTHER ENVIRONMENTAL EFFECTS ON IMMUNISATION UPTAKE FOR CHILDHOOD IMMUNISATIONS

6.1 Outline of Chapter 6

International literature identifies a range of complex reasons affecting immunisation coverage uptake. The ultimate decision to proceed with childhood immunisation lies with the joint decision-making between the parents/caregivers and the healthcare provider. However, behind this, there are a range of influences on the parents, family and the HCPs, resourcing and structural support issues, as well as external influences affecting their knowledge and attitudes.

This chapter focuses on some of the broader environmental aspects that may affect the ability to achieve a fully immunised child. Clearly, there are many broad issues that can all impact on this outcome (Refer Chapter 3). However, in this chapter, I confine the discussion to the areas of research in which I have been involved. Firstly I discuss a study that looks at immunisation coverage disparities by demographics. In the second part of this chapter I discuss research undertaken specifically looking at the role of the media as an influence on both parental and HCP knowledge, attitudes and confidence.

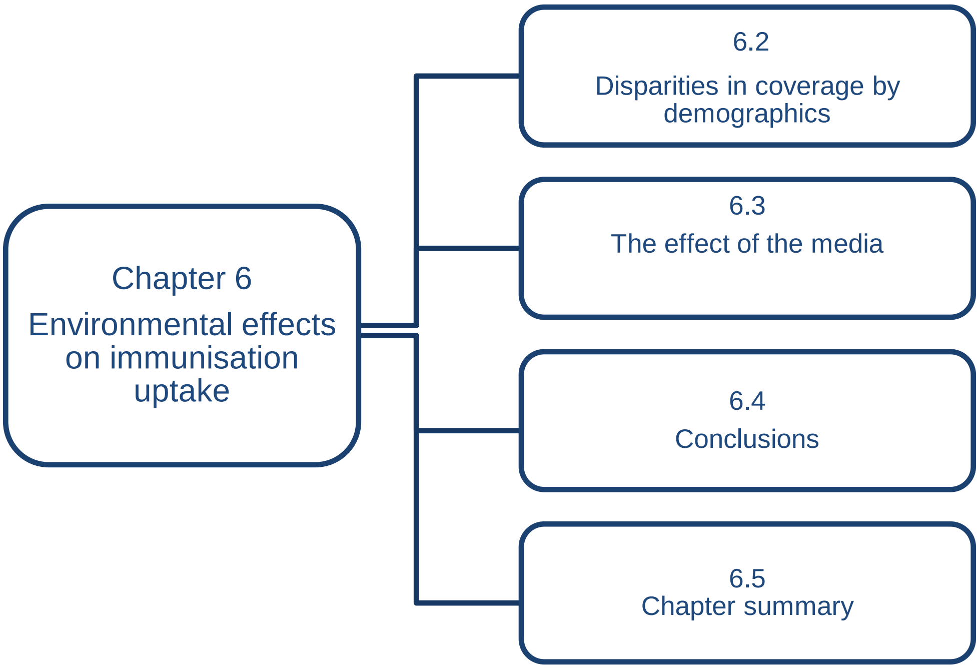
Chapter 6
Environmental effects on immunisation uptake
6.2
Disparities in coverage by demographics
6.3
The effect of the media
6.4
Conclusions
6.5
Chapter summary

Figure 6.1: Outline of Chapter 6

6.2 Disparities in coverage by demographics

6.2.1 Introduction

To gain analytical help to consider more in depth questions around immunisation coverage and disparities, I had been working with my colleague Dr Dan Exeter from the Section of Epidemiology and Biostatistics, School of Population Health, University of Auckland. Dan has expertise in spatial epidemiology. We were fortunate to have a Masters student, Steffen Exeter, who was interested in supporting our research questions further. Steffen undertook his Master's thesis looking at measuring spatial distribution and disparities in coverage for the NZ childhood immunisation programme (28). This research team also included my colleague in IMAC, Dr Helen Petousis-Harris, and Associate Professor David O'Sullivan, who supported Steffen with the analysis. The manuscript development was also supported by Steffen's colleague Christoph Buck from the Institute for Epidemiology and Prevention Research, Bremen, Germany. I was involved in the planning, design, and writing up of this study, but had no involvement in the statistical analysis, except to give advice on the clinical aspects as to how they applied to the statistical boundaries.

6.2.2 Background

As described in Chapter 2, it had been historically identified that NZ has disparities in immunisation coverage rates, particularly by socioeconomic group and ethnicity. There had also been some trends identified in the 1991-1992 and 2005 national surveys to suggest there were regional differences (5). As outlined in Chapter 3, the international literature shows a strong relationship between low immunisation coverage and SES (62), a range of possible geographical variations (refer Chapter 3 Table 3.2), and a more mixed relationship with ethnicity (refer Chapter 3, Table 3.3). With the introduction of the NIR in 2005, NZ was now in a position to analyse and report on data more effectively than previously. This aim of this study was to use the newly developed NIR data to describe the immunisation coverage status for NZ infants and evaluate risk factors for lower immunisation uptake for a national cohort of 12-month-old children born over a three year period. The demographic characteristics we chose to focus on were geography (by DHB), socioeconomic deprivation, and ethnicity.

6.2.3 Methods

Anonymised immunisation coverage data were obtained from the NIR, provided by the MoH. Data were extracted on all children who turned 12 months of age between 1 January 2007 to 31 December 2009. Individual immunisation status was defined as the completion of all vaccines before 12 months of age for the three events of the primary course. The schedule changed in this study period, with the course being reduced from six injections to three in June 2008 with the introduction of combination vaccines. Therefore, the total count depended on the date of birth of the child in relation to the schedule. The epidemic meningococcal B vaccine (MeNZB^{TM}) was also given through this period, but was excluded from this study. Ethnicity data were coded using the NZ prioritisation approach, whereby multiple ethnic affiliations are categorised in order of priority according to perceived need for NZ (Māori, Pacific, Asian, NZ European and 'other'). The 'other' ethnicity group comprises all other ethnicities living in NZ, including African, Middle Eastern, South American, as well as a proportion of NZ Europeans who identified themselves as 'New Zealanders' or 'Kiwis' in the Census data.

Each patient record from the NIR was assigned a spatial reference as a Meshblock, which represented an area where the address is given by the parent/caregiver at the first contact with the healthcare system after birth. This is the smallest level of aggregate Census data collection in NZ. There are 41,392 Meshblocks containing approximately 40 people in rural areas and on average 100 in urban areas (200). Socioeconomic differences were measured using the 2006 NZ Deprivation Index (201). This measure is based on small area socio-economic data from the NZ Census and comprises nine variables representing both material and social deprivation in the population (including income, unemployment, qualifications and household characteristics, such as overcrowding). Immunisation update rates were calculated for all eligible children for each ethnic and deprivation category on a national scale and by the 21 DHBs. A multivariate lognormal regression model was applied to analyse the effects of ethnicity, deprivation and the combined interaction of the two with the underlying population proportion.

6.2.4 Results

The original dataset consisted of 187,533 childhood records and of these, 26,303 (14%) were excluded. The excluded included missing spatial references (8%), missing NZDep scores (2%) and records flagged as opt outs (4%). Opt outs were excluded because they were missing the immunisation status information. The final data set was 161,230 records. Overall, 85.4% (95% CI: 85.2-85.6) of eligible children were fully immunised at 12 months of age.

Geography

There were significant variations across DHBs with a range from 75% coverage in the lowest performing DHBs of Lakes and Northland, to over 94% in South Canterbury and Otago DHBs. There was a significant north-south gradient with higher rates in the South Island. Refer Figure 6.2.

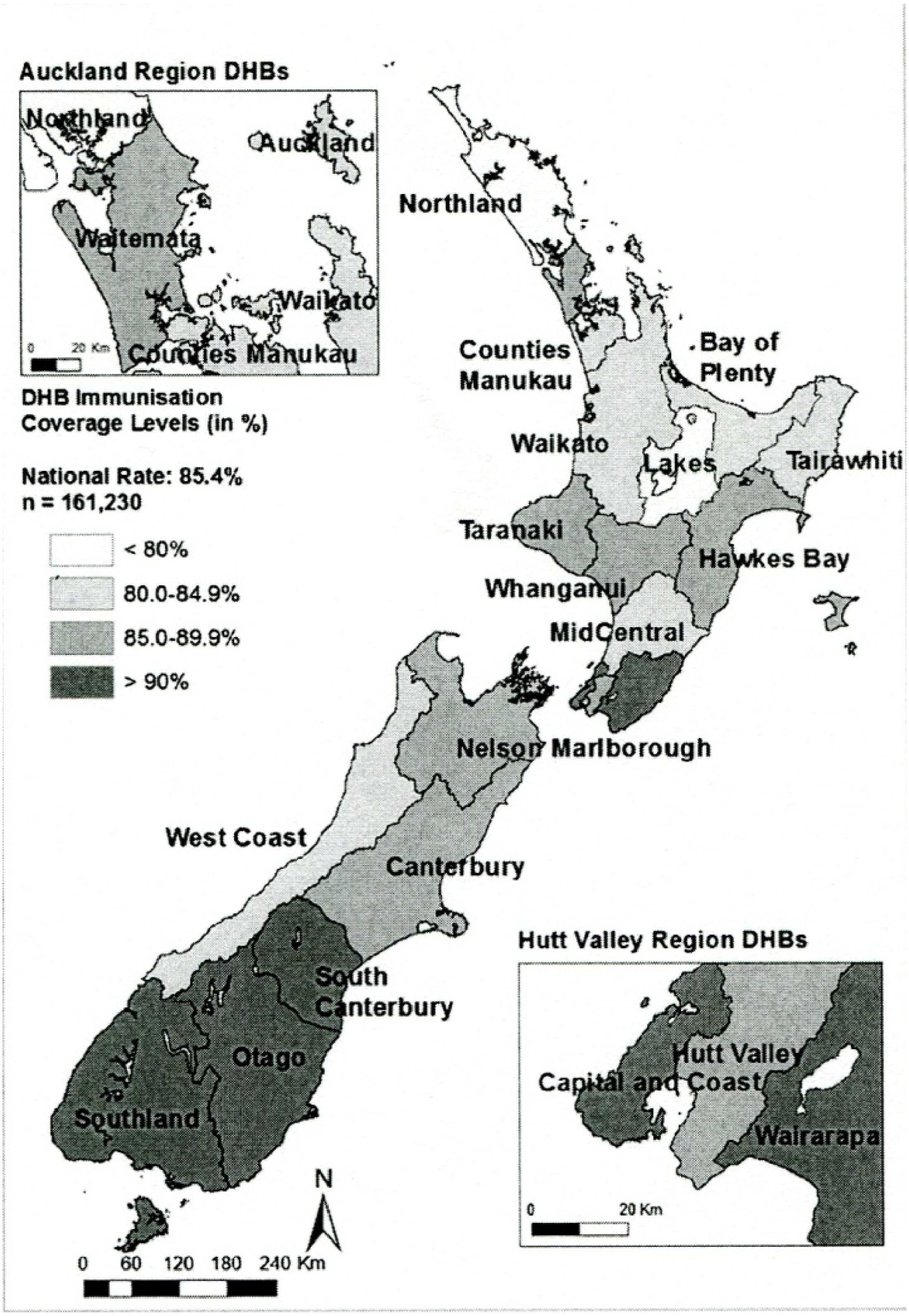

Figure 6.2: Geographical distribution of immunisation coverage for children aged 12 months 2007-2009

Deprivation/Ethnicity

Figure 6.3 shows a clear gradient by deprivation from the lowest quintile groups having 81.1% (95% CI 81.5-82.1) versus the least deprived quintile at 89% (88.8-89.3). Figure 6.3 also demonstrates marked ethnic differences, stratified by deprivation. NZ European had the highest coverage overall at 91.8% (95% CI 91.6-

92.0), followed by Asian 86.3% (85.7-86.9) with the lowest rates for Māori at 78.1% (77.7-78.4). There was a 16% gap between the best and lowest performing populations.

Stratifications by ethnicity and deprivation showed that Māori children in particular presented the most distinct negative gradients across the deprivation categories with a more than 10% uptake difference between low and high deprivation areas. Refer Figure 6.1. The ethnicity category of 'other' demonstrated the lowest uptake rates for both the low and the high deprivation areas with 83.9% (83.2- 84.6) and 81% (79.8-82.1) respectively.

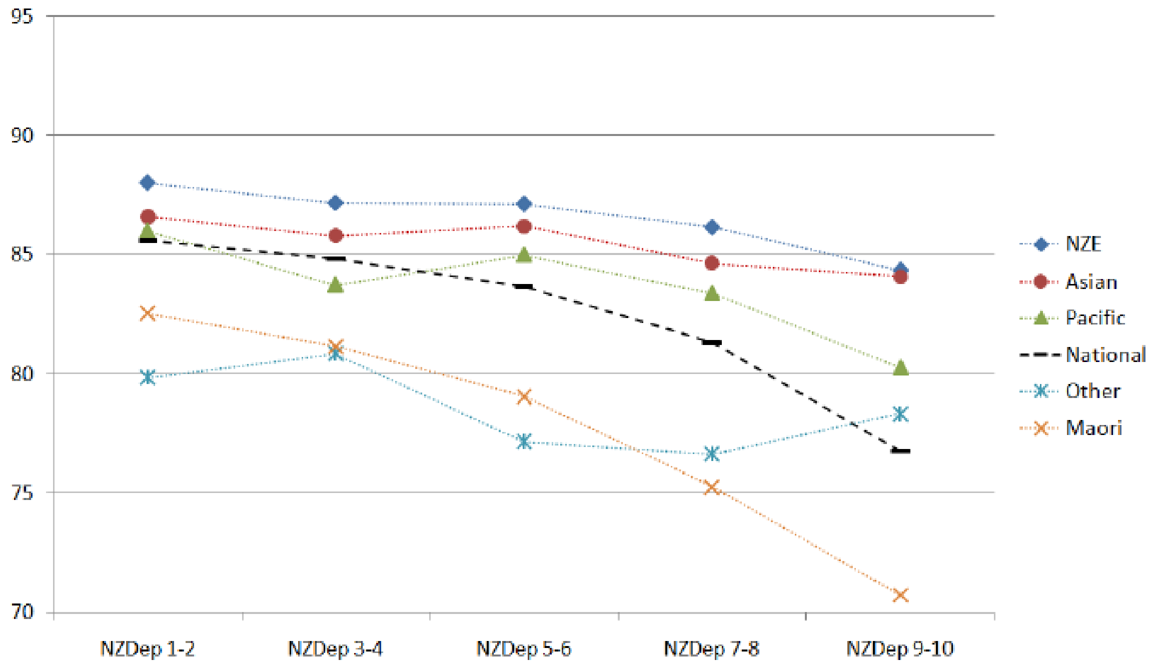

Figure 6.3: The proportion of children fully immunised at 12 months of age by deprivation (NZDep) in quintiles and ethnicity

6.2.5 Further unpublished data: Association with independent risk factors

Steffen undertook further statistical modelling on the same data, where he identified variables from the NZ Census data that we considered to be possibly linked to barriers to accessing immunisation and mapped them by meshblock to the NIR coverage rates. Refer Table 6.1. His multivariant analysis demonstrated that ethnicity was the most significant association, with Māori children being two-thirds less likely to be immunised than NZ European. Significant associations with likelihood of lower immunisation were demonstrated for children from bigger households, single parents, households with the income derived from a government benefit, deprivation status and overall household income. There was no association with education variables.

Table 6.1: Likelihood of being immunised at 12 months of age, using NIR data and census data for children born 2007-2009

Variables		Odds Ratio	95% CI
Demography	**Ethnicity**		
	NZ European	1.0	
	Maori	0.36	0.35 - 0.38
	Pacific	0.53	0.50 - 0.56
	Asian	0.58	0.55 - 0.62
	Other	0.42	0.40 - 0.44
Socioeconomic Status	**Household Income**		
	1 very high household income	1.0	
	2	0.98*	0.94 - 1.02
	3	0.91	0.87 - 0.95
	4 very low household income	0.83	0.78 - 0.87
	Household income from Benefit		
	4 least dependent from benefit	1.0	
	3	0.95	0.91 - 0.99
	2	0.98*	0.94 - 1.03
	1 most dependent from benefit	0.93	0.88 - 0.98
	Telephone Access		
	1 very high level of telephone access	1.0	
	2	1.10	1.05 - 1.15
	3	1.02*	0.98 - 1.06
	4 very low level of telephone access	0.97*	0.93 - 1.01
	Vehicles in Household		
	Two or more vehicles in household	1.0	
	One vehicle in household	1.03*	0.96 1.10
Household Characteristics	**Single Parents**		
	4 very low level of single parents	1.0	
	3	0.98*	0.94 - 1.02
	2	0.99*	0.94 - 1.04
	1 very high level of single parents	0.89	0.85 - 0.94
	Number Household Members		
	Two Member Household	1.0	
	Three Member Household	0.88	0.85 - 0.91
	Four Member Household	0.73	0.69 - 0.77
	Five and more Member Household	0.61	0.55- 0.66

*Not significant (>0.05)

6.2.6 Conclusions

For the first time, the use of NIR provided an opportunity to examine coverage levels for entire birth cohorts with spatial mapping. Both ethnicity and deprivation were significant determinants of low immunisation coverage. Of note is that this is not just a straight deprivation issue - ethnicity also has an independent significant effect. The group that had the lowest immunisation coverage was identified as both Māori and from lower socioeconomic background. The effect on disparities was even more pronounced when considered by geographical distribution, with the lowest performing areas in the North Island and a nearly 20% difference between the highest and lowest performing DHBs.

We argued that socio-cultural issues impact particularly for Māori households through risk factors such as single parent households and/or larger households. The inequalities in the 'other' ethnic group were very striking across all SES groups. We recommended that this population group be given more consideration because, despite being the third largest ethnic group in NZ, it is likely to be very heterogeneous. More attention also needed to be paid to the marked geographical variations across DHBs.

This was the first NZ research utilising NIR data to undertake analysis of disparities in immunisation coverage. It showed there were significant geographical, socioeconomic and ethnic differences in the NZ setting for the infant immunisation programme uptake as measured at 12 months of age. The group identified of most concern were Māori from the poorest backgrounds, where there appeared to be a dual effect of both ethnicity and SES. Further unpublished data has shown some linkages to independent variables that may explain some of the challenges for this group and this includes larger household sizes and households with sole parents. Interestingly these early data did not show any link to education variables. We did not have the resources at the time to pursue this line of research further, but future directions need to consider these disparities and look more in-depth into the specific elements creating the disparity in each of these groups and, in particular, for lower income Māori families.

6.3 The effect of the media

6.3.1 Background

It is well recognised internationally that any form of mass communication, including media activities, can directly affect community confidence in immunisation and translate through to lower immunisation uptake. (Refer Chapter 3 Table 3.4). NZ commentary in 1998 raised the concerns that media reports questioning vaccine safety could be significantly increasing parental concerns (196). Because there was no NZ research on this topic, and it was felt to be an important contributing factor to immunisation uptake, as part of our broader focus on immunisation coverage we undertook research on the role of the print media in the NZ setting. In NZ, the reach of the combined mainstream print media is wide, covering all homes in all regions at least once a week, including many free regional newspapers (15). However, we have no information on how well read they are. All the following research discussed below was funded through IMAC and the Department of General Practice and Primary Health Care with the support of University of Auckland summer studentships (15-17).

6.3.2 Immunisation in the print media

6.3.2.1 Introduction

The first study was an analysis of the content of print media reports, both magazine and newspapers, with respect as to how they addressed issues on immunisation and VPDs (15). The focus was on how they presented information on immunisation and VPD to their target audiences and whether they were supporting, neutral or opposing perspectives. A secondary focus was on what changes occur over time and the possible influences of these changes. The research team comprised Felicity Goodyear-Smith, Helen Petousis-Harris, myself and two medical students, Stephen Ram and Colleen VanLaar, who jointly undertook the data collection and assisted in analysis.

6.3.2.2 Methods

The data consisted of print media clippings from 400 national and regional publications for the two years of 2001 and 2003. These years were chosen because 2001 was a year when there was a change in the timing of the delivery of the MMR vaccine, and the announcement of a planned shift from OPV to IPV for 2002. A 12 month period, two years later, was chosen as a contrast. The clippings were obtained from a professional agency that inspected all national daily and weekly newspapers and the non-daily suburban and provincial papers and magazines, including health-related publications. All articles, letters to the editor and opinion columns were provided that mentioned the words ‘immunise/immunisation’, ‘vaccine/vaccinate’, and any of the nine VPDs on the childhood schedule (poliomyelitis, diphtheria, whooping cough/pertussis, tetanus, haemophilus influenza type b, hepatitis B, measles, rubella, and mumps).

After initial reading of the material, discussion between our research team determined that the articles would be coded according to their perspective – whether the article was seen as ‘supportive’, ‘neutral’ (containing only informative information and not expressing any stance on immunisation) or ‘opposed’ to immunisation. Articles were then categorised and coded by a researcher and entered into an excel database with fields including date, type of article, region of the media source, the vaccine(s), disease(s) referred to, any mention of disease epidemics or adverse events, and the ‘perspective’ code as defined above. The database was then converted into Access for analysis and Epi-info was used to find values of significance. To assess the reliability of the coding, 20 randomly-selected articles were submitted to a blinded independent reviewer.

6.3.2.3 Results

A total of 2,113 articles were included, 1,228 from 2001 and 885 from 2003. From the 2003 period, 26 articles had no attached date or source. These were included for analysis for 2003, but not in the analysis regarding region, type of media or date.

Perspectives

Of the total 2,113 clippings, 33% (704) were classified as supportive, 17% (362) as opposing and 51% (1,081) as neutral.

Opposition

Overall, 20% of all the media opposed to immunisation was from the region of Northland, despite the fact that Northland has only 3.7% of the national population.

Media opposed to immunisation was significantly higher in 2001 ($\chi^2 = 189.46$, p= <0.001; df = 1) with 27% (328/1,228), versus 4% (34/885) in 2003. Of all the opposed, 66% (240/362) were letters to the editor and expressed the opinion of an individual or organization. Of note was that these were often repeated and circulated through several local newspapers throughout the country, and most of these articles were written by the same small group of authors. Of all the anti-immunisation media, 66% consisted of opinion pieces in 2001 (225/335), versus 44% (15/34) in 2003 showing a significant decrease ($\chi^2 = 8.26$; p≤0.004; df=1). Media opposing immunisation was present most often in local (294, 81%) rather than national publications (9, 2.5%). Anti-immunisation media was markedly lower, although not absent, in medical publications (7/1117, 6%). Articles mentioning Māori or Pacific people also had a lower number of opposing views towards immunisation (9/112, 8%) compared with 17% across the whole sample. Anti-immunisation media regarding the MMR vaccine was more prominent in 2001 than in 2003, with 201 articles versus 12 (χ^2= 110.39; $p \leq 0.0001$; df = 1). The next most commonly mentioned vaccines among anti-immunisation media were influenza and meningococcal vaccines, which were both more commonly mentioned in 2001 than 2003.

Adverse events following immunisation (AEFI)

Overall, 501 articles mentioned AEFI. Of the total 362 articles classified as opposing, 264 (73%) mentioned adverse events, with the majority of these (179) concerned with the MMR vaccine. In 44 of the opposing articles adverse events were mentioned with no link to a specific vaccine, and in these articles adverse events were often described using emotive language and described tragic personal stories.

Media supportive of immunisation

Overall 33% (704/2,113) of the total were supportive articles and were consistent between 2001 (35%) and 2003 (31%). Thus the proportion of those positive to immunisation was significantly higher than that of anti-immunisation in the total sample period (33% versus 17%; χ^2= 146.74; $p \leq 0.0001$; df=1). Most of this media was present in informative rather than in opinion-based articles in both years. Supportive media was under-represented in letters to the editor (98/387, 25%) compared to anti-immunisation (222/387; 57%). Medical publications and articles mentioning Māori and Pacific people appeared to have higher proportions of pro-immunisation media than the overall trend.

Changes over time

The diseases and vaccines in focus were different between 2001 and 2003. MMR was prominent in both years and mentioned in 23% (480) of all the articles; however, the total in 2001 was 444 compared with only 36 in 2003. Measles disease followed the same pattern. In 2001 MMR was almost equally associated with pro-immunisation and anti-immunisation media. This changed in 2003 when the proportion of anti-immunisation media decreased. Pertussis was a common disease mentioned in both years, appearing in 10% of all disease concern articles. Overall, pertussis disease and pertussis-containing vaccine was more often expressed in pro-immunisation rather than anti-immunisation media. There was a non-significant trend for more anti-immunisation media regarding pertussis vaccines in 2001 to 2003 (23% versus 10%; χ^2= 3.36; $p \leq 0.067$; df=1).

6.3.2.4 Conclusion

Media activity can directly affect immunisation uptake in both positive and negative ways. This research has shown the majority of anti-immunisation media tended to focus on adverse events, mostly in letters to the editor, made emotive appeals and cited tragic personal stories. With the exception of the MMR vaccine, they did not tend to refer to specific vaccines. The specific interest in the MMR is expected to be related to the international interest in the vaccine following allegations (proven incorrect) that the vaccine may be related to autism and Crohn’s disease, which created a significant amount of international attention (196). In contrast, pro-immunisation media tended to be more informative, less opinion-based and was seen in more publications mentioning Māori and Pacific populations. As the challenges for immunisation coverage were well recognised as being even greater for these populations, it is of no surprise that the pro-immunisation media gave more attention to these ethnic groups.

Limitations in the study included its restricted scope to just print media, given the wider accessibility of the NZ population to television and radio and the growing social media networks. We identified the need for further studies to examine article discourse and further published data below discusses this.

6.3.2.5 Discussion and recommendations

In this article, we discussed the concerns that the growth and reach of the mass media may create a vehicle for anti-immunisation individuals and groups to communicate more widely and rapidly. This can serve to amplify their influence. Internationally, it had already been well established that the effect of amplification of personal viewpoint via media, as was seen in the 1980s and 1990s, with the fears over pertussis vaccine linked to brain damage that had dramatic international effects of reducing the uptake of pertussis vaccination in many Western countries with resultant disease outbreaks (117) and the more recent effect of the personal opinion of Dr Andrew Wakefield from the UK with his allegations of a link with MMR vaccine to autism (118). In this study, amplification was seen with a small number of authors dominating the anti-immunisation letters to the editor across large geographical areas.

It was of interest that the style of the anti-immunisation media shifted from less opinion-style to more information-style articles in 2003. We were unsure if this was a deliberate strategy from the proponents or just a change in the main players. However, clearly there were still a few key anti-immunisation players dominant in this media.

There were significantly more articles and perspectives in the media around immunisation in 2001 than 2003, and particularly those opposing immunisation. We speculated there was a range of reasons why there was a positive trend towards reduction in anti-immunisation messages in the NZ media. Firstly, the development of IMAC is likely to have contributed. IMAC had, and continues to have, a large focus on proactive and reactive management of media issues and takes a very active role in the media. Secondly, more attention to the fact that NZ had a signification problem at the time, with low immunisation coverage was also likely to have galvanised other pro-active activity at the MoH and district levels.

We speculate that the amplification of issues, particularly speculation around purported vaccine side effects, add to the anxiety that parents have identified as a challenge to their decision-making for childhood immunisations, as outlined in Chapter 5.

Strategies we recommended based on this research included the consideration of increasing the proportion of letters to the editor supportive of immunisation, both rebuttals to articles and letters opposing immunisation, as well as letters supportive of immunisation in response to articles written with a ‘neutral’ stance towards immunisation. These were strategies that IMAC, working with the MoH, had been developing. Strategies also included providing a few key accessible, media-trained personnel who could talk on a wide range of immunisation issues. All issues posed by the media are taken seriously and responded to promptly. Relationships with national and local journalists remain, to this day, an important part of this strategy. We noted that several front-page alarmist stories, such as the results of an inflammatory and dubious study on the relationship between MMR vaccine and autism (202) were prevented by this strategy when we had key people available to journalists to follow up rapidly on new information prior to going to press.

In summary, using this example with the print media, we identified the importance of maintaining confidence in immunisation and vaccine safety at the community level, the role that mass media plays in this and the potential for public health services such as IMAC to work closely with the media to mitigate the inappropriate use of damaging misinformation in the media.

6.3.3 The use of media headlines

6.3.3.1 Introduction

In response to the meningococcal epidemic in NZ, a mass immunisation campaign for all children from birth to 20 years of age was instigated, starting in South Auckland in 2004 and rolling out nationally through 2005. Because we were already aware of the effect of media activity, and the importance of this on parental confidence and awareness affecting immunisation uptake (117), we used this opportunity to investigate the print media through the meningococcal campaign. This was a small study funded through IMAC. I was the Principal Investigator working closely with Helen Petousis-Harris. We utilised the services of an IMAC researcher, Deon York, to collect the data. This research focused on tracking single issue stories from their source during the meningococcal B campaign, tracking through the NZ print media and examining how the headlines for the stories were presented in different media in terms of accuracy or misleading presentations with respect to the story (17). It is important to be aware that it is not the journalist who crafts the story who generates the headlines in print media. This decision is usually made by the subeditor of the newspaper. There had been no known published research on the topic of media headlines of which we were aware at that time.

6.3.3.2 Methods

NZ print media clippings were collected from 400 different national and regional publications for the years of 2004 and 2005. Articles were obtained from a professional agency which inspects all national daily and weekly newspapers, non-daily suburban and provincial papers and magazines, including health related publications. They provided copies of all articles that made reference to immunisation, vaccine or vaccination.

6.3.3.3 Results

Five thousand articles were collected and entered into an Excel database with fields including date, type and region of media source, title and coding themes. To analyse the use of the headlines, all the articles were scanned for multiple articles that arose from an original single NZ Press Association story and were then taken up broadly by many media throughout the country. Three case studies were then selected, based on the origin being a single factual story around the meningococcal epidemic and vaccine, and from there having wide print media coverage to many regions in the country.

Story A

It was reported that initially one, then two, young children had caught meningococcal disease and were in hospital. While it was not known exactly what strain of meningococcal disease they had contracted, it was established that neither had the epidemic strain against which the vaccine is effective. Both children had recently been fully immunised against the epidemic strain, but this vaccine does not cover other strains of meningococcal disease.

The original story generated a total of 30 print media articles around NZ between the dates 22 November to 2 December 2004. Of the 30 articles, nine had accurate headlines, six had ambiguous headlines, and 15 had misleading headlines. Refer Table 6.2. Two of the articles were from national media and both were in the misleading headlines category.

Table 6.2: Story A: Comparing accuracy of headline to content of article

Accurate	Ambiguous	Misleading
"Immunised tot catches another strain of disease"	"No meningococcal vaccine 100 percent effective – ministry"	"Child not protected"
"Vaccinated child catches different meningitis strain"	"No vaccine ever 100% effective, says ministry"	"Vaccinated child in hospital"
"Vaccinated child catches different strain of disease"	'No meningococcal vaccine 100 percent effective'	Toddler struck down
"Vaccinated child catches variation"	"Vaccine not '100 percent effective'"	"Vaccine fails"
"Vaccinated boy sick with another strain of killer bug"	"Vaccinated children still at risk"	"Immunised children catch killer disease"
"Stay vigilant"	"Jabs can't give complete cover"	"Vaccine fails to protect"
"Jabs can't cover all strains"		"Two children develop meningococcal disease despite being immunised"
"Jabs can't protect against all strains"		"Two children ill despite vaccine"
"Vigilance advised"		"Two children have disease"
		"Two ill, despite vaccine"
		"Two develop meningococcal disease after vaccine"
		"Two children developed meningococcal disease after vaccine"
		"Children catch disease
		Two meningococcal cases despite immunisation"
		"Sick children no surprise to anti-jab campaigner"
n = 9 (30%)	n = 6 (20%)	n = 15 (50%)

Story B

This story announced the first day of the launch of the meningococcal vaccination programme for children aged six months to five years in Central Auckland and Northland. The content included the launch announcement and discussed the vaccine safety, in particular quoting the Independent Safety Monitoring Board and the clinical trials findings, which all had found no major safety issues. The story also quoted the opinion of an anti-immunisation lobbyist, who gave an anecdote of children reputed to have reactions to the vaccine. This story generated eight articles all on the same day, three were accurate and five misleading. Refer Table 6.3.

Table 6.3: Story B: comparing accuracy of headlines to content of article

Accurate	Misleading
“Meningitis jabs begin”	“Dispute over vaccine risk goes on”
“Pre-schoolers get jabs”	“Mass vaccination proceeding despite concerns”
“Vaccinations begin”	“Vaccine debate continues, 25,000 face needle”
	“Vaccine row rages”
	“Meningococcal vaccine risk dispute goes on”
n = 3 (37.5%)	n = 5 (62.5%)

Story C

The Minister of Health visited a health centre and announced a milestone in the campaign: more than two million meningococcal B vaccine doses had been delivered nationally to almost 78% of the eligible population. The programme aimed to achieve 90% coverage with all three doses, and the Ministry spokesperson reported that it was unlikely to reach this goal in all areas, but was likely to reach targets in the most important high-risk groups. The story generated a total of 13 articles over the period 18-19 August, and a further article on 31 August 2005. In total seven headlines were accurate and six were misleading. Refer Table 6.4.

Table 6.4: Story C: Comparing accuracy of headlines to content of article

Accurate	Misleading
“Acceptance of vaccine widespread”	“Vaccination goal may be missed: Ministry”
“Milestone for vaccine plan”	“Vaccine drive short of goal”
“Vaccine campaign reaches 2 million”	“Vaccine goal unlikely to be met”
“Two million doses delivered”	“Vaccination campaign falling short”
“Heavy dose”	“Campaign falls short”
“Two million doses of vaccine delivered”	“Meningococcal likely to miss target”
“”Two million doses of vaccine now delivered”	
n = 7 (54%)	n = 6 (46%)

6.3.3.4 Conclusions

From the three case studies there was a total of 51 articles, of which 26 (51%) had misleading headlines, 6 (12%) ambiguous headlines and 19(31%) accurate headlines.

6.3.3.5 Discussion and recommendations

These small case studies illustrate graphically the difficulties arising at the intersection of the media and public health interests. The needs and drivers of the print media often differ from the public health drivers. Media needs are driven by the need to sell the story and engage the audience; there is less need for the accuracy of a health message. While research had been focused on the actual accuracy of articles and journalist accuracy in articles, no attention had been paid to the impact of the headlines and how they match, or do not match, the article. Headlines are usually developed by subeditors who are likely to be more concerned with effective reach than accuracy of message which is effectively illustrated here with over 50% of the headlines being misleading.
We recommended the need for broader relationships with many levels of media, not just with the journalists and national origins of the stories but also the local management of the stories and headlines. We need to recognise the inherent tension at times between public health publicity and print media needs. To reconcile these competing needs we suggested health planners develop a greater awareness of triggers and drivers in the media world.

6.3.4 Use of immunisation arguments in the print media

6.3.4.1 Introduction

Following the above studies, we chose to explore in more depth how the anti-immunisation arguments are presented in the print media, and whether we could identify themes and styles in the arguments. The aim was to gain an understanding of the use of anti-immunisation rhetoric, so as to be able to better identify and respond to it. It had already been demonstrated in the international literature that anti-immunisation rhetoric generally contained errors of fact and/or of logic (fallacies) (203,204). While this literature had examined factual aspects of anti-immunisation rhetoric and the arguments had been well documented, none had examined them for fallacies of logic.

With the financial support of IMAC and the Department of General Practice and Primary Health Care, Helen Petousis-Harris taking the lead alongside Felicity Goodyear-Smith, we chose to further examine the issues around the presentation of the logic. We used the services of a summer studentship through the Department of General Practice and Primary Health Care with student Kamya Kameshwar as part of the team. The concept and planning for focusing on fallacy in anti-immunisation rhetoric came from the inspirations of Felicity Goodyear-Smith and Helen Petousis-Harris.

A fallacy is a component of an argument that is demonstrably flawed in its logic, therefore making the line of reasoning invalid. It is useful to be able to identify flawed reasoning in order to be confident about the error in the reasoning and enable effective and convincing refutation of errors. There are, historically, many different ways of classifying certain fallacies. As discussed in the introduction in our published article, the original identification of flawed reasoning came from Plato, followed by Aristotle who was the first to name the 13 different types of errors in reasoning or in logic (16) Developing from this history, there are now various competing and overlapping ways to classify fallacies: The Internet Encyclopaedia of Philosophy lists the 177 most common ones! However, broadly fallacies can be classified as formal, where the structure or form is flawed and informal where the argument has valid form but the premises are false and therefore cannot support the conclusion.

6.3.4.2 Methods

A content analysis was undertaken of the major daily NZ newspapers with the aim to crucially examine the construction of the immunisation-related arguments by describing and classifying errors of fact and fallacy. NZ print media clippings were used from the database described above (15) collected from 400 different national and regional publications. For this study, all newspaper articles that made reference to immunisation, vaccine or vaccination between January 2002 and December 2007 from the daily papers of four major NZ urban centres were accessed (The New Zealand Herald; The Press; The Dominion Post; The Otago Daily Times) from the larger database. Data recorded included origin and date of publication, type of article, title, author, page number, and the type of vaccine the article addressed.

Errors of fact

All articles were assessed for statements that were false errors of fact regarding any comment made or implied on vaccine safety, efficacy and /or effectiveness. Fact was verified via the peer reviewed evidence-based literature of the time. Comments supported by the majority of scientific literature were classified as substantiated and coded green. Unsubstantiated were coded red. Based on the overall makeup of its content (the number of lines coded green and red) each article was assigned a substantiation score between one and five, where the number corresponded with one of the content analysis measures:

1. All statements substantiated.
2. Some statements unsubstantiated.
3. Equal proportions of substantiated and unsubstantiated statements.
4. Most statements unsubstantiated.
5. All statements unsubstantiated.

Descriptive statistics were performed to calculate the frequency of unsubstantiated claims for the changes over time. A random selection of 10% of the articles was independently assessed and coded by two other members of the research team, and Kappa analysis was used to test their level of agreement.

Errors of logic

All articles were then reassessed for errors in logic. We chose to use the taxonomy proposed by Aristotle to illustrate that modern fallacies may still be described using ancient logic. These are grouped into:

1. Formal errors of logic (the structure is flawed and deduction is invalid):

- *Non-sequitur* (claim purports to show causality)
  Post hoc ergo propter hoc (affirming the consequent - assumes a causal relationship because one event follows another in time).
  Cum hoc ergo propter hoc (denying the antecedent - assumes a causal relationship because one event occurs at the same time as another).
- *Petitio Principii* (begging the question).

- *Circulus in Probando* (arguing in a circle or assuming the answer).

2. Informal errors of logic (these have a valid form but false premises, which do not support the conclusion):
    - *Dicto simplicter ad dictum secundum quid* (fallacy of accident - makes a generalisation that disregards exceptions).
    - *Dicto secundum quid ad dictum simpliciter* (reverse accident – argues from a special case to general rule).
    - *Fallacy of the consequent* (draws a conclusion which the premise does not support).
    - *Verbal fallacies* (uses words in an inappropriate manner, for example emotive language, to make or support a claim).
    - *False attribution* (appeals to irrelevant, unqualified, biased or fabricated source).
    - *Red herring fallacies* (argument given in response to another argument, not addressing the original issue).
    - *Ignoration Elenchi* (irrelevant conclusion, diverts attention away from a fact in dispute rather than addressing it directly).
    - *Argumentum ad hominum* (addresses purely personal considerations – shoots the messenger).
    - *Argumentum ad verecundiam* (attributes to misleading authority).
    - *Straw man argument* (based on misrepresentation of an opponent's position).
    - *Fallacious anecdotal evidence* (uses personal accounts or experiences in an ambiguous fashion to support a claim).

Note that use of anecdotal evidence sometimes may be valid, when personal accounts or experiences are employed in an illustrative fashion.

The second dataset developed included the source of the article, the type of error, the quote containing the error, and the person or organisation to which the error was attributed. Examples of each type of error of fallacy were presented.

6.3.4.3 Results

Errors of fact

A total number of 360 articles, with an average of 60 per year, were reviewed and given a substantiation score. Independent coding of the scores gave a Kappa score of 0.97, indicating a strong level of inter-rater agreement.

Overall, 21% (n=76) of the articles contained some factually unsubstantiated information about vaccine efficacy or safety. There were three types of error, as seen in Table 6.5. Articles reporting new vaccines were usually accurate, e.g. the HPV vaccine where, of 24 articles, only one contained any scientifically incorrect information. Similarly, articles referring to well-established vaccines not in routine use, such as rabies or the historical vaccine for smallpox, were all factual. On the other side, 33% of all articles about the MMR vaccine contained erroneous information, as had been similarly demonstrated in our earlier study (15). Just over a quarter (26%) of articles about the new meningococcal B vaccine contained scientifically unsubstantiated information.

Table 6.5: Examples of errors of fact about vaccination efficacy, effectiveness of safety in the NZ print media 2002 - 2007

Type of error	Example	Comment
Erroneous Statement	But there is evidence it [ADHD] is aggravated by substances that get into the child's body from other sources, such as antibiotics, lead in the environment, possibly vaccination, as well as food." Auckland GP, NZ Herald 2006	There is no evidence in the scientific literature that ADHD is aggravated by vaccines.
Error of omission	Eighty percent of those given the vaccination in a NZ trial had a reaction to the vaccine and no placebo tests were conducted, Mr Peters told Parliament. The Dominion Post, 20 October 2004	Almost all of these reactions were minor local injection-site reactions. Placebo controlled trials were considered unethical and unnecessary, as enough bridging data was available.
Error of commission	MeNZB vaccination is free and safe. Otago Daily Times 20 June 2005	Vaccination is not always safe – serious adverse events occur on rare occasions

Errors of logic

Many articles contained a number of errors of logic (fallacies) as well as fact. These met most of the types of fallacy in our taxonomy. Refer to examples of these in Table 6.6. While these errors were predominantly used by those opposed to immunisation, pro-immunisation was not exempt from these errors as well. Most of the fallacies occurred in quotes within the articles rather than as a result of the assessment by the reporter.

Table 6.6: Examples of errors of logic about immunisation in the NZ print media 2002 - 2007

Type of error	Example
Post hoc ergo propter hoc (affirming the consequent)	*An Oamaru pupil says the meningitis vaccine caused him to collapse and spend a night in hospital*. Reporter, Otago Daily Times, June 2005
Cum hoc ergo propter hoc (denying the antecedent)	*…some reports suggest there are high levels of absenteeism as a result of that [MeNZB injections]. When vaccination coincides with the beginning of the cold and flu season, you would expect to see quite high rates of absenteeism. We believe all vaccines place a strain on the immune system*. Immunisation critic, NZ Herald, 2005
Circulus in Probando (arguing in a circle)	*You've got to give kids' immune systems a chance to grow. It's better to build immune systems so they can fight things themselves* Reporter, The Press, 2006
Dicto simplicter ad dictum secundum quid (fallacy of accident)	*MeNZB vaccination is free and safe; and all three injections of the MeNZB vaccine are needed.* Ministry of Health, Otago Daily Times, 2005
Dicto secundum quid ad dictum simpliciter (reverse accident)	*Critics of the programme say the toddler was a victim of vaccine failure and are calling for a Royal Commission of Inquiry into "how a nation can be so totally swayed by officials and advisers into spending a quarter of a billion dollars for such a gamble that has delivered false hope to trusting New Zealanders*. Reporter, NZ Herald, 2006
Fallacy of the consequent	*Some people don't like altering the children's immune systems with anything. Kids that don't get immunised are actually healthier on the whole*. GP, The Press, 2005
Verbal fallacies (emotive language)	*A United States scientist is leading an international team of researchers using an army of blood-sucking mosquitoes to produce a potentially potent vaccine against malaria*. Reporter, NZ Herald, 2006 *These child guinea pigs for the nation* [children receiving MENZB vaccine]" Reporter, The Press, 2004
False attribution	*Flu vaccines are ineffective and possibly unsafe, a British study has found.* Reporter, Dominion Post, 2006 *Risk analyst Ron Law, a critic of the vaccination programme, said the programme had been a failure.* Health reporter, NZ Herald, 2006
Ignoration Elenchi (irrelevant conclusion)	*Ms Claridge* [Immunisation Awareness Society] *says that during the 50 years leading up to the 1940s when vaccination programmes began, the incidence of communicable diseases had already dropped dramatically because of better sanitation, hygiene, water supplies, housing and nutrition* Reporter, Dominion Post, 2002 *She says that diseases, such as scarlet fever, have also declined hugely during the past 110 years, despite the absence of a vaccination programme.* Immunisation critic, Dominion Post 2002
Argumentum ad hominum (shoot the messenger)	*I realised one day that there were two kinds of doctors – there is the GP who knows bugger all about a lot and the specialist who knows a lot about bugger all*. Vaccine critic, NZ Herald, 2006 *And you can be sure that doctors Tukuitonga and Turner will not be taking the blame because, for all their protestations of immunisation safety, they would not know an adverse reaction if it jumped up and bit them*. NZ Herald 2002
Argumentum ad verecundiam (attribute to misleading authority)	*The Society says breastfeeding for at least 6 months and a healthy diet and environment for children provide better protection* [than immunisation] The Immunisation Awareness Society, The Press, 2006
Straw man argument	*The medical profession says Pamol is completely safe*. Reporter, NZ Herald 2004
Fallacious anecdotal evidence	*I have seen case histories of children, and spoken to other doctors whose children decompensated [regressed] so drastically after the MMR, that you can't deny that in some cases it happened*. Neurologist parent of child with autism, NZ Herald, 2006

6.3.4.4 Conclusions

This study reviewed errors, both in fact and logic, in print media in NZ over a six-year period. A weakness of this study is that while we developed a relatively robust taxonomy of fallacies, there is no one international standard for this and some errors may be able to be categorised into more than a single category simultaneously.

6.3.4.5 Discussion and recommendations

We concluded that understanding how arguments written in the media are constructed can assist health professionals firstly, in better recognising flaws in logic, and secondly, themselves avoiding the use of fallacious arguments. We accepted that, in the media, the presentation of a range of views is seen as useful when the level of knowledge is incomplete and continuing to evolve. However, we argued that established health issues such as NIPs have already been scrutinised for scientific validity, including having already been assessed by many experts, hence it is not something that can often be evaluated based on a media story presenting a range of quotes in pursuit of ‘balance’.

We commented in our discussion that, ironically, introducing a balance of personal view of a subject such as immunisation can introduce bias with public health the casualty. We did note that there appears to be a cycle with new vaccines that, prior to introduction, the media coverage appears less emotive and more scientifically substantiated. However, following the routine use of a vaccine the proportion of unsubstantiated reporting increases. As per our earlier study (17) we again raised the concern about the potential for conflict between the drivers and constraint of journalists versus health professionals.

Errors of fact and logic are used commonly, however more commonly by anti-immunisation proponents. The media often appear content with providing a diversity of opinion without feeling the need to put further effort into verification or accuracy or source.

We called for more awareness in the media and in public health spokespeople for the need for better accuracy in reporting, recommending this be part of their regular training and reviewing and highlighting fallacious comments. We also raised the issue of being more prepared for challenges that arise with the introduction of new vaccines and the expected pattern of initially supportive media frequently followed by suspicion and anti-science rhetoric. Finally, we focused on the need for all health professionals to be aware of the challenges of communicating in the media, including how language can be misused. *The best product in the world will not sell without knowing how to communicate it to the audience* (16)*.*

6.4 Chapter conclusions

The greater environmental effect of parents and healthcare professionals, and all the different aspects of this that may affect their decisions to encourage or discourage childhood immunisation, is a very broad topic. I have not attempted to cover all aspects here, but just touch upon two areas of study that I saw as potentially important contributors to the low immunisation coverage rates in the NZ context.

There is clear international and local evidence that socioeconomic factors feature prominently in affecting immunisation uptake. Other factors that may be allied to this in the NZ context were likely to be geography and ethnicity. The introduction of the NIR in 2005 gave us a unique opportunity to further look at these factors. Our first research utilising the NIR focused on spatial distribution and disparities in coverage. It was of no surprise that we categorically showed the strong effect of deprivation. The NZ Deprivation gradient for these years shows an 8% difference in immunisation coverage between the least to the most deprived households. NZ Deprivation is not based on a single measure, but includes household income, unemployment, qualifications and household size. Showing an effect of deprivation does not identify which factors are more important than others. Further analysis suggested that the factors that were most significant included household size, with households comprising five or more members being nearly 40% less likely to have their infants fully immunised than those of smaller households; overall, household income being low leading to 20% less likely to have fully immunised infants; and households with solo parents being nearly 10% less likely to have fully immunised infants. Of interest was that we did not show a difference with education variables. While parental education variables appear strongly associated in the lower income developing countries (84), the educational achievements of the parents are less consistently associated in the higher income countries.

Unexpectedly, we showed, at this point in time, that geographical and ethnic differences were even greater than socioeconomic ones.

There was a nearly 20% geographical difference between the highest and lowest performing DHBs and because this cannot all be assumed to be due to some areas having much higher rates of deprivation and high needs populations than others, this raised the question that there were other factors affecting this that may be pertinent to the health care services in these areas. These factors are explored in more depth in the following chapters.

There was a dramatic ethnic difference with the lowest performing ethnic group being Māori and overall, Maori children being two thirds less likely to be immunised than NZ European. This was the strongest association that we have shown. When stratified by SES, Māori showed the greatest stratification, with a 10% difference between those from the lowest relative deprivation areas to those from the highest. Essentially, what we are identifying is that the group in most need of targeting is particularly low income households identified as Māori, more likely to be large families and/or have sole parents as part of the makeup.

We have been able to present this data widely to the MoH, DHBs and wider health professional networks: Firstly, this has helped to understand more effectively and focus on the children most likely to be missing out on immunisation, and secondly to raise the question for health services as to why there was such marked geographical variability, which is likely to be more than just explained by having high numbers of children in high-risk groups.

Our second area of attention with environmental influences was to look at the NZ print media. Over three studies, we highlighted many challenges, with inaccuracies both in articles and in headlines in the national and regional media. Important findings around print media anti-immunisation sentiment showed this was dominated by a few prolific players, repeated stories, mostly focused on perceived immunisation side effects, often emotive with anecdotal stories and more through letters to the editor and opinion pieces. These also tended to run more in local than national media. International damaging media clearly also has its effects in NZ, particularly the prominence of the concerns around MMR and autism that arose in the UK getting much coverage and inaccurate reporting in NZ.

The media often appear content with providing a diversity of opinion without feeling the need to put further effort into verification or accuracy or source. However, this is not always the case. Media supportive to immunisation focused more around informative articles, much less often emotive or opinion-based and particularly when mentioning Māori or Pacific children, were more likely to be supportive of immunisation. Media coverage appeared to reduce over time, particularly with proportionately less anti-immunisation sentiment.

Errors of fact and logic are very common in print media. We identified at least one in five print articles containing unsubstantiated information about vaccine safety or efficacy. There appears to be a cycle with new vaccines - prior to introduction, the media coverage appears less emotive and more scientifically substantiated. However, following the routine use of a vaccine, the proportion of unsubstantiated reporting increases.

Errors of logic in particular, had not been explored in the international literature around the immunisation topic previously, and we identified common repeated flaws in logic in many discussions. It is important to understand the structure of how an argument is written to assist health care professionals and media management in both recognising flaws in logic and avoiding them themselves.

We identified the importance of maintaining confidence in immunisation and vaccine safety at the community level, the role that mass media plays in this and the potential for public health services, such as IMAC, to work closely with the media to mitigate the inappropriate use of damaging misinformation in the media. We raised the concern around the potential for conflict between the drivers and constraints of journalists versus health professionals.

6.5 Summary of Chapter 6

This chapter focused on some aspects of the environment that affect childhood immunisation coverage. The first research presented here used for the first time the new NZ data from the NIR to identify in more depth the disparities in coverage. This dramatically highlighted the challenges, particularly for children identified as of Māori ethnicity and from poverty. An unexpected finding was the larger than predicted discrepancies between different geographical areas, as identified by DHB boundaries. The second part of this chapter presented three novel studies looking at the use of the print media with respect to the childhood immunisation programme. The intention of these studies was to focus on research that could be of most use to inform and direct improvement of immunisation coverage. I have been privileged to be able to present all these data at national and local levels in NZ to support external strategic direction and to inform internal strategy for IMAC.

CHAPTER 7 THE CONTRIBUTION OF HEALTHCARE PROVIDERS’ KNOWLEDGE AND ATTITUDES TO CHILDHOOD IMMUNISATION COVERAGE

7.1 Outline of Chapter 7

International literature identifies that the most significant barriers to immunisation coverage are family poverty factors, delivery systems, healthcare provider factors and family and child factors (194). This chapter focuses on the healthcare provider. It aims to present and discuss the published research I have undertaken with colleagues since 2004, focusing on NZ HCPs, their knowledge and attitudes to immunisation and their resource needs. As the front line providers in NZ are PNs and GPs, the emphasis of this research is on this group.

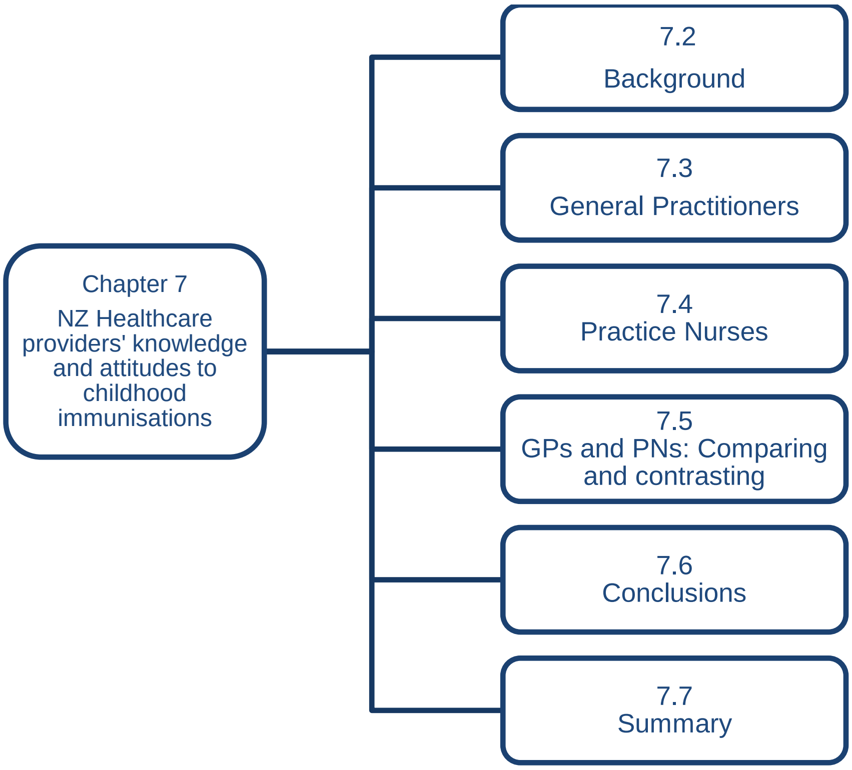
Chapter 7
NZ Healthcare providers' knowledge and attitudes to childhood immunisations
7.2
Background
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Figure 7.1: Outline of Chapter 7

7.2 Background

My earliest research into factors that affected immunisation coverage had looked at parental knowledge and attitudes. The international literature had identified that the knowledge and attitudes of healthcare professionals (205,206) is as important as parental issues, if not more so. UK and USA literature had found that the commitment of the provider was likely to be the most important determinant of obtaining high immunisation coverage (206), even in the face of parental uncertainty and socioeconomic deprivation (207,208). While there were mixed opinions as to how much was due to healthcare professional knowledge and how much was due to their attitude and commitment, some of the international studies did suggest that poor HCP knowledge, rather than attitudes, may be the single most important factor in vaccine uptake (88,186,210). Because there was no published literature in NZ on this important topic, we clearly needed some local research.

With limited resources, we were unable to consider all HCPs. Hence we took the decision to focus research on the front-line professionals, the PN and the GP. In the NZ context, all infant immunisation events are delivered in the general practice, with the exception of outreach services. It was estimated in 2003 that approximately 93% of all childhood immunisations are delivered in the general practice setting by the PN (12) and around 80% of PNs administer immunisations independently without GP referrals (22). A small number of sole GP practices (around 7% at the time) did not employ PNs and therefore would give immunisations to children themselves.

In most general practices GPs and PNs work closely as a team, which comprises the front-line staff for educating parents, supporting the informed consent process, precall, recall, ordering and stocking vaccines and immunising children safely. The GP is less likely to immunise directly, but to educate parents and to opportunistically support them to immunise their children. The PN's role also involves all aspects of immunisation - ordering, cold chain maintenance and delivery, precall /recall and audit activities. National recommendations in NZ are for at least one PN in a practice to obtain 'authorisation' which enables him/her to immunise without being under oversight of the GP. Authorisation involves undertaking a vaccinator training programme, two-yearly updates and following a process to demonstrate competency via the local Medical Officer of Health.

7.3 General Practitioners

7.3.1 GP Study One

7.3.1.1 Background

The major vaccine supplier of the NZ childhood primary course in 2002 was Glaxo-Smith Kline. I was able to access a grant from GSK to fund a study focusing on the knowledge and attitudes of NZ GPs to immunisation. GSK had no involvement in the design or delivery of the study. Helen Petousis-Harris undertook the role of Principal Investigator and again we worked closely with Felicity Goodyear-Smith on this project. I had employed a medical doctor with expertise in public health, Dr Ben Soe, in IMAC at the time and Ben was engaged particularly on the data analysis and interpretation. We employed a project manager, Jenny Wilmshurst, to set up the project and nurse researcher, Janet Brown, who undertook most of the interviews. My role was in the instigation of the project, accessing funding and, together with Helen and Felicity; we designed, oversaw the data collection, and were all involved in the analysis, discussion, and conclusions. This was published in 2004 (12).

7.3.1.2 Methods

The aim was to understand immunisation issues confronting GPs by converging both quantitative and qualitative text data (triangulation, a mixed-method design). This was a national telephone study undertaken between July 2002 and January 2003. The inclusion criterion was any doctor working in a NZ general practice, either part or full time. Those working in locum tenure positions were excluded. The practice needed to be actively carrying out childhood immunisation events. We obtained a randomised list of 1283 national general practices from a commercial vendor. At this time, this was considered to be the most comprehensive and reliable data on practising GPs in the country. Where the practices were multi-practitioner, the interviewer spoke to the first practitioner available. A sample of 150 was selected, based on a sample-size calculation, which used the following assumptions: a population of approximately 3000 (the total number of NZ GPs) with an expected frequency of 53% would know that egg allergy is not a contraindication to the receipt of MMR immunisation with a range of 8% and 95% CIs. This figure was based on a UK study around knowledge of primary care physician knowledge base at the time (206).

The questionnaire was designed based on the areas identified in the international literature around HCP knowledge and attitudes affecting immunisation uptake. Also included were questions around perceived educational needs and preferred sources for obtaining immunisation information. The telephone interviews were facilitated by a computer-assisted telephone survey tool (CATI) that managed both the sample and the questions. The interview was approximately 20 minutes and answers were entered directly into the database. Quantitative responses included yes/no answers, Likert scales, multi-choice options, and demographic data, including age, gender of the GP and nature, length of time in, and location of, the general practice. Qualitative data involved free-form answers to questions and included the GP's perceived barriers to immunisation not already covered in the quantitative questions and services provided by the GP for childhood immunisation.

Statistical analysis was undertaken using the chi-square test and p-value to analyse for significance, looking for difference between groups. This was to determine differences between age groups, numbers of years in general practice, urban versus rural practice, and responses to the key areas. Qualitative data were analysed using a general inductive approach. Individual text responses were initially reviewed to identify themes and then collated for emerging categories. These were combined into major themes through discussion and re-reading of the data by two researchers until consensus was reached. The data were independently double-coded as a consistency check and discrepancies were resolved by adjudication.

7.3.1.3 Results

A total of 250 practices were contacted to obtain a sample of 150 participants, giving a 60% response rate. Of the 100 non-responders, 23 (9%) refused to participate, 12 (5%) were initially willing but decided they were too busy after call-backs. In 25 (15%) of cases the receptionists refused to put the call through to the GP, 17 (7%) were lost to follow-up by failure to call back before the end of the survey and 23 (9%) did not meet the inclusion criteria.

Demographic breakdown showed 111 (74%) were male, 123 (82%) worked full time which was defined as at least eight/tenths, 51 (34%) worked as sole practitioners, 35 (23%) were in rural settings, 122 (81%) had been working as a GP for ten or more years with 46 (31%) more than 20 years. The average age was 44 years, with 119 (79%) in the 40 to 49 year age group.

These demographics were similar to those of the RNZCGP membership documented in 2001 from 1996 and 2000 data in terms of age, years in practice and geographical spread. However, we had a greater proportion of rural participants compared with the national population (23% compared to 15%) and more male participants compared to the national population of GPs (74% compared to 64% nationally). There were no significant inter-gender differences in responses to several key questions.

GP-perceived barriers to immunisation

Below are listed the most commonly reported perceived barriers to receiving childhood immunisation events.

I. Parental fears, identified by 53 (80%).
II. Lack of funding for providers, identified by 66 (44%).
III. Lack of time for providers to offer services, identified by 42 (28%).
IV. Poor Ministry direction, identified by 27 (41%).
V. Parental difficulties accessing services, identified by 13 (20%).
VI. Lack of interest in the topic by providers, identified by 11 (17%).
VII. Lack of health professional knowledge, identified by 8 (12%).

The view that lack of knowledge in the health professional was a barrier to immunisation was more likely to be stated by GPs under 40 years (χ^2=6.54; 1 df p = 0.001). Urban rather than rural practitioners were more likely to consider patient difficulty in accessing services as a barrier (χ^2=9.84; 1 df $p \leq 0.002$).

When providers were asked about other barriers to immunisation that were not covered by the above list, the strongest theme to emerge was misinformation. Concerns were particularly around misinformation distributed by both midwives and the anti-immunisation lobby groups. GPs considered much parental fear arose from this misinformation. Secondly, they identified a lack of resources, both to inform themselves and also to help educate patients and counter misinformation. A third theme was the lack of opportunity to immunise, either due to having a very mobile population or because the practice no longer had access to women antenatally or in the early postnatal period. Further themes included structural issues such as changing schedules, cold chain challenges, and a few GPs articulated they felt there was apathy on the part of their patients towards immunisation and lack of awareness of the diseases.

GP knowledge of immunisation

Table 7.1 summarises GP responses to specific knowledge questions around immunisation. The examples used were knowledge of contraindications to MMR and pertussis-containing vaccines.

Urban, rather than rural, GPs were more likely to know that a rash in response to eating eggs was not a contraindication to MMR immunisation (χ^2= 11.21, 1 df, p= 0.0008). GPs who had been practicing for less than 10 years expressed more desire for further knowledge about vaccine side effects (χ^2 = 4.5, 1 df, $p \leq 0.05$). GPs under 40 years of age and those who had been in practice for less than 10 years were more likely to view parental fear of immunisation as a barrier (χ^2 = 7.26, 1 df, p= 0.007 and χ^2 = 5.62, 1 df, p= 0.018).
Nearly 5% of GPS felt that six weeks was too young to start immunising, and a further 6% felt six weeks was sometimes too young.

The resources that GPs were most likely to use for further information were the Immunisation Handbook from the MoH (97.3%), their local immunisation coordinator (53%), CME (63.3%) and colleagues (66%), most commonly a PN. Only 47.3% used the internet and of these, the preferred sites were the MoH, CME websites, CDC and databases such as Medline. The added information that 69 GPs wanted was categorised into four areas: (1) updates on their own knowledge on disease and vaccines; (2) patient resources (to counter misinformation, risk versus benefit information and non-English resources); (3) rapid communication on emerging issues such as media responses; and (4) travel information.

Table 7.1: Results for GP perceived contraindications to receipt of MMR and pertussis-containing vaccines

	Correct answer % (n)
Perceived contraindication to MMR vaccination	
Infant gets a rash eating eggs	36 (54)
Infant has spina bifida and hydrocephalus	48 (72)
Infant being treated for leukaemia*	56 (84)
Mother pregnant	66 (99)
Infant has a febrile convulsion at 11 months	73 (110)
Infant with snuffly cold/nasal discharge	79 (119)
Sibling has ADHD, Autism or Aspergers	81 (122)
Mother breast feeding	89 (133)
Infant reported to have had measles	91 (137)
Infant has eczema	95 (143)
History of parental febrile convulsions	97 (145)
Perceived contraindication to pertussis-containing vaccine	
Infant had an HHE following previous immunisation	6 (9)
History of parental febrile convulsion	97 (14)
Screaming for >3 hours after previous immunisation	39 (58)
Infant had apnoea in first 3 weeks of age	50 (75)
Infant had motor delay*	65 (97)
Infant has spina bifida, no leg weakness	65 (97)
Infant with snuffly cold/nasal discharge	85 (127)
Older sibling had fever following pertussis immunisation	94 (141)
Infant has eczema	97 (146)
Sibling has eczema or asthma	100 (150)

** = a genuine contraindication*

7.3.1.4 Discussion

This was the first survey of NZ GP knowledge and attitudes around childhood immunisation to be conducted. A limitation of the study was that only 60% of those randomly selected participated, and while they matched the NZ demographics of GPs, there is no way of knowing whether those that did not participate had different views.

The most common GP-expressed concern around barriers to achieving immunisation was parental fears around immunisation, particularly perceived side effects. This matched our findings from research with NZ mothers (9). Many GPs expressed concern that they no longer had contact antenatally to engage and support parents in the decision-making. The second most common barrier was the lack of funding to providers to offer services.

We recommended that NZ needed more strategies to recognise and respond to parental fears. We also highlighted GP concerns about lack of funding and recommended the government increase the funding. Following this recommendation, we were contracted by DHBNZ to undertake further research into the cost of immunising at the general practice level. Refer Chapter 8 Section 8.

It was of interest that the younger GPs appeared to be more aware of their knowledge gaps and had more desire for additional knowledge. The difference between rural and urban GPs was unexpected and there seems no clear explanation for this finding. Rural GPs were less likely than urban GPs to regard access issues as a barrier, which highlights that access issues are likely to be more complex than just distance barriers.

There were clear large gaps in GP knowledge base around contraindications to vaccines. Of particular concern was that around one in ten GPs was not convinced that an infant should start their immunisation programme at six weeks. This shows a gap both in knowledge of infant immunology, and also in the reasons behind the timing of the immunisation programme for best disease control. Other gaps in GP knowledge were also likely to affect immunisation uptake; for example, 15 to 20% of GPs would not immunise a child with snuffles or a runny nose, leading to considerable potential for missed opportunities to immunise. As this was of significant concern, we undertook further research on the topic of missed opportunities, which is presented in Chapter 8 Section 8.3. GPs rated their own lack of knowledge as the least likely factor in low immunisation coverage, despite the fact that there were very significant gaps in their knowledge around contraindications. It seemed very clear from this research that GP education needed considerably more attention than it had been given up until this point.

7.3.2 GP Study 2

7.3.2.1 Background

The next research we undertook focusing on GPs was two years later. This was part of a larger HRC-funded study that looked at the contribution of all the different aspects of the general practice to immunisation uptake of childhood vaccines. Other aspects from this study will be discussed further in Chapter 8. The Principal Investigator for the overall HRC study was Associate Professor Cameron Grant and the core research team involved Cameron, myself, Felicity Goodyear-Smith, and Helen Petousis-Harris. Felicity took the lead authorship for the focus on GPs. Felicity Goodyear-Smith, Ngaire Kerse and I were the GP members of the team and undertook the initial engagement of the practices for recruitment. Following our approach, the researcher employed by the study, Deon York, and the research project manager, Jackie Copp, followed up for the majority of the data collection. Dr Joanna Stewart gave statistical advice. This was published in 2009 (21).

At the time of this study (2004), we recognised that, while overall NZ had mediocre immunisation coverage, there were general practices that showed they were capable of obtaining and maintaining high immunisation coverage (211). The aim of this study was to identify the characteristics that were associated with GPs working in practices that obtained higher practice immunisation coverage and more timely delivery of immunisations than the national average. We hypothesised that firstly, GP attitudes about immunisation influence the completeness and timeliness of immunisation of their infant patients and secondly, that more accurate knowledge about VPDs, vaccines, adverse events and contraindications, would be associated with higher infant immunisation coverage.

7.3.2.2 Methods

General practices in the two regions of Auckland and Midland were selected and enrolled into the study during 2005 and 2006. Approximately 50% of NZ children aged up to 4 years reside in these two regions. A sample size of 125 practices was chosen to be sufficient to yield 80% power to show statistical significance at the 5% level for a practice characteristic associated with higher coverage or more timely immunisation delivery, if this characteristic was present in 20 to 25% more of the practices with higher coverage/better timeliness. These calculations assumed the characteristic being examined had a frequency between 10 and 70%. Sample selection was random, based on a commercial list of all general practices in these regions, with purposeful oversampling of practices that were under Māori governance.

Practice coverage and timeliness was measured by an independent electronic audit of each practice's PMS. Each recruited practice was visited by the researcher Deon York and, at this visit, the date of birth and immunisation records of the children registered at the practice were electronically downloaded. Coverage and timeliness were calculated for each practice from this dataset. The percentage of registered children at each practice who had received all of their schedule immunisation events, and the percentage that were delayed for any of the immunisation events was described. Immunisation coverage was defined as the percentage of registered children who had received all of their NZ national schedule immunisation events. The third dose assumption was used when estimating this percentage. This states that if the third in a series of vaccine events was recorded as given, then it is assumed that the previous two events had also been given, regardless of whether they had been recorded or not. This assumption results in a small overestimate of coverage that is considerably less than the underestimate which occurs if only recorded doses are counted (212). Immunisation delay was based on the NIR definition which stated that a delay was an event not received within four weeks of the due date for the six week event, and within six weeks for the three month, five month, and 15 month events. A CATI was conducted with one randomly selected doctor from each practice. The interview included demographics (age, gender, length of time in general practice, and working hours), their views on barriers to childhood immunisations, educational needs, knowledge of vaccine safety and contraindications, attitudes, resources available, and immunisation education of parents. The interviews lasted approximately 20 minutes, with answers entered directly into the database for collation and analysis. Quantitative responses included yes/no answers, Likert scales, and multi-choice options, and the questionnaire was based on the one previously adapted by us in our 2002 study (12).

Analysis was undertaken by Cameron Grant using SAS software. The proportion fully immunised and the proportion with no delayed immunisation were both transformed to facilitate analysis using the arcsin of the square root of the variable. The transformation made the variance constant across the distribution of coverage and timeliness at each practice. Two general linear models were created with arcsin of the square root of the proportion immunised and the proportion with no immunisation delay as the respective outcome variables. Univariate associations of GP characteristic variables with practice immunisation coverage and timeliness were determined. Associations of GP characteristics with coverage and timeliness were then examined in a multivariate model that included variables that described social deprivation, age of the registered children at each practice, practice region, and practice type of governance. The practice, PN and caregiver characteristics were also included in the multivariate model, but not reported in this particular study. Statistical significance was defined as a p value of < 0.05.

7.3.2.3 Results

There were 124 practices selected: 72 from Auckland and 52 from Midland. This included all 11 Māori governance practices in Auckland and a random sample of 31/50 from the Midland region. Refer Figure 7.2 below for a summary of the recruitment and enrolment process and Figure 7.3 for a summary of all the data sets collected for the full study.

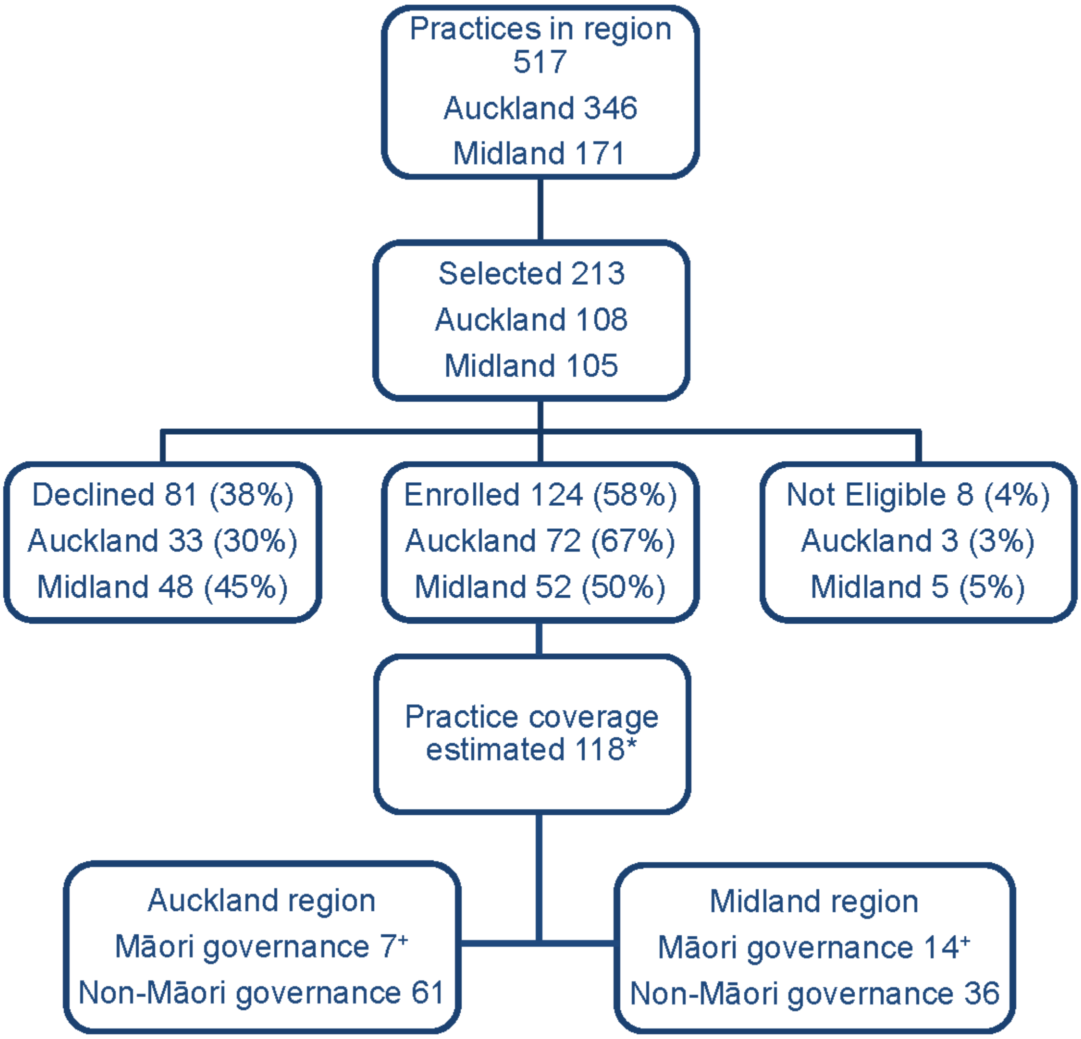

Figure 7.2: Summary of practice recruitment and enrolment

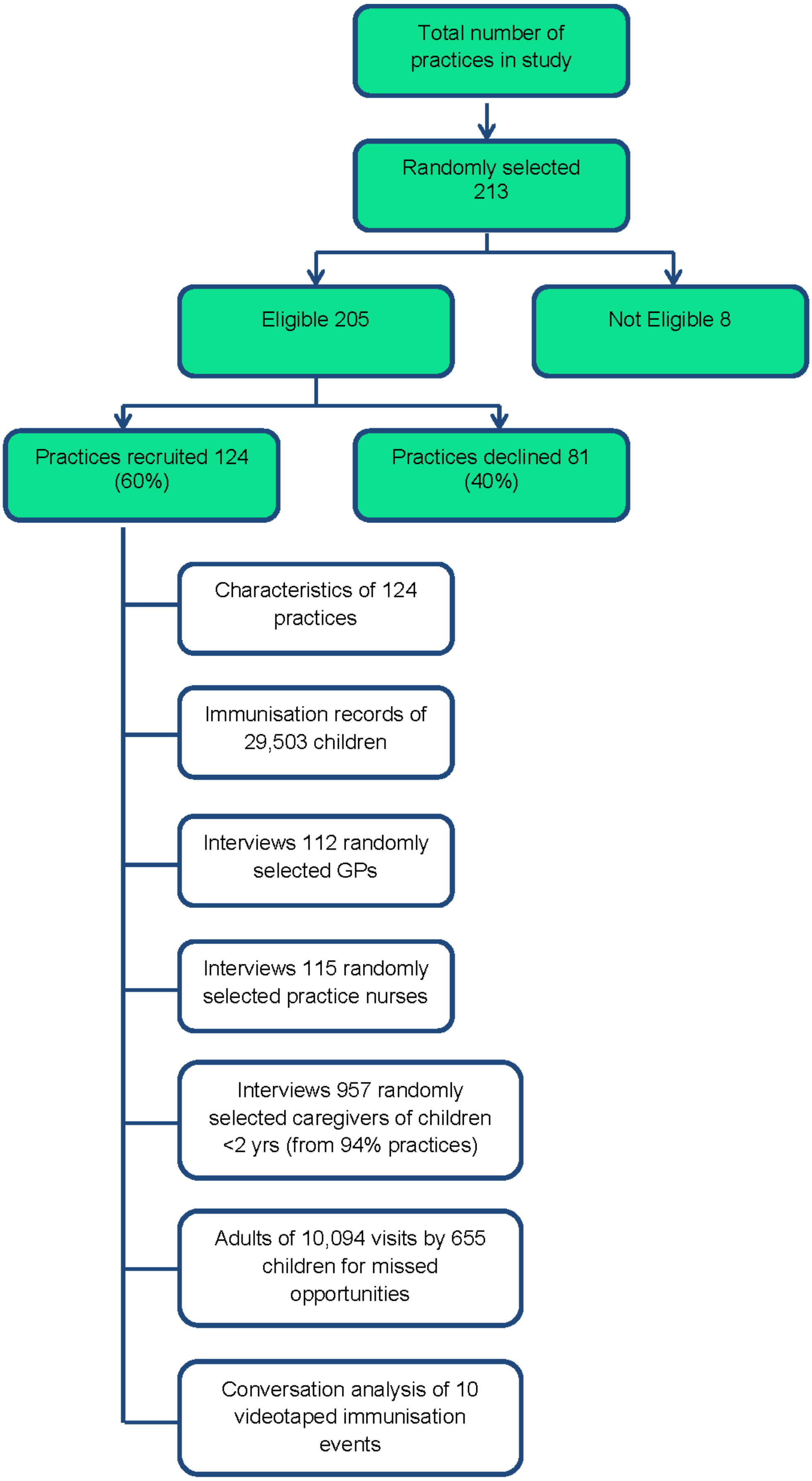
Total number of practices in study
Randomly selected 213
Eligible 205
Not Eligible 8
Practices recruited 124 (60%)
Practices declined 81 (40%)
Characteristics of 124 practices
Immunisation records of 29,503 children
Interviews 112 randomly selected GPs
Interviews 115 randomly selected practice nurses
Interviews 957 randomly selected caregivers of children <2 yrs (from 94% practices)
Adults of 10,094 visits by 655 children for missed opportunities
Conversation analysis of 10 videotaped immunisation events

Figure 7.3: Summary of all data sets in the study of immunisation determinants

One hundred and thirteen GPs were interviewed, of whom 75 (66%) were male and 35 (34%) were female, with 87 (77%) aged between 40 – 59 years. There were significantly more female GPs under age 40 years compared with male (9/38; 24% compared with 7/75; 9%, Fishers exact p=0.04). Ninety (80%) were working full-time. Forty-eight (42%) had more than 20 years, 37 (33%) had 10 to 19 years and 28 (25%) less than ten years of practice experience. In general, these demographics are similar to those of the RNZCGP membership.

Almost all GPs (108; 96%) believed immunisation to be important. The main sources of obtaining immunisation information for over 90% of GPs were their PN colleagues and the NZ Immunisation Handbook from the MoH, followed by named medical websites and CME for over 50%.

Of the total, 93 (82%) felt comfortable with their knowledge of immunisation. However, 85b (75%) could not identify what the acronym 'CARM' stood for (Centre for Adverse Reactions Monitoring). Although allergy to egg is not a contraindication to receiving MMR, 14 (12%) incorrectly thought this was and 16 (14%) failed to identify that immunisation should be delayed in an infant receiving treatment for leukaemia. In total, 33 (29%) stated they would delay the MMR immunisation if the infant had a cold or runny nose. The majority correctly identified that eczema, a previous febrile convulsion, a sibling with autism, baby previously reported to have had measles or the mother pregnant or breast-feeding are not contraindications to MMR. Only 20 (18%) correctly identified that a motor delay in an infant was a precaution to pertussis immunisation. Of the total group, 59 (52%) incorrectly identified previous hypotonic hypotensive episodes (HHE), 23 (20%) prolonged screaming, and 21 (19%) apnoea as contraindications to giving pertussis vaccine.

Ten (9%) thought six weeks is sometimes too young to start immunising, giving reasons including premature birth, low birth weight, early medical problems, serious infections, or parent disagreement.

Fifty (66%) either agreed, or totally agreed, that parental apathy, fear, and ambivalence or uncertainty regarding immunisation were barriers to improving uptake. Other barriers identified included lack of transport, the anti-immunisation lobby, inaccurate media information, misinformation, and cultural values. Generally, patient access difficulties, lack of funding and time for providers, health professional knowledge, or poor ministerial direction were not considered barriers to uptake.

In the univariate analysis, factors that were significantly related to higher immunisation coverage at their practices were GPs knowing that fever is not a contraindication to immunising; that leukaemia is a contraindication to use of MMR vaccine; identifying what CARM stands for; using the immunisation handbook at least monthly and GPs spending a long time discussing informed consent with first-time parents. Refer Table 7.2. Variables reviewed and found to be not significant, included rurality of GPs, attending at least one practice meeting in the past month, perceiving parental ambivalence as a barrier, GP gender, other questions regarding contra-indications and GP immunisation learning needs.

When region, governance, social deprivation and age of the child were adjusted for, GP knowledge with respect to fever not being a contraindication (p=0.0089) and confidence in their knowledge (0.0183) remained significant, as seen in Table 7.3 and continued to remain significant in the final multivariate model. Refer Table 7.4.

With respect to immunisation timeliness, similar factors were found to be significant in the univariate analysis, but after adjustment for region, governance, social deprivation, and age of the child the only significant contributor to immunisation timeliness was whether the GP perceived parental access difficulties as a barrier.

Table 7.2: The association of GP characteristics with immunisation coverage at the practice

GP characteristic		**Median practice coverage %**	**P value Univariate**	**P value Adjusted***
GP correct that fever not a contraindication	yes	71	0.3057	0.0089
	no	70		
GP confident in knowledge about immunisation	yes	72	0.0490	0.0183
	no	67		
GP correct knowledge about leukaemia as contraindication	yes	74	0.0067	0.0358
	no	63		
GP perceives parental access difficulties as a barrier	yes	70	0.3604	0.0386
	no	71		
GP correctly identifies what CARM[¥] stands for	yes	74	0.0003	0.0591
	no	68		
GP strongly agreed that practice teamwork was strong	yes	74	0.0709	0.1514
	no	70		
GP perceives parental apathy as a barrier	yes	69	0.0976	0.1875
	no	74		
GP using immunisation handbook once a month or more	yes	74	0.0099	0.2135
	no	62		
GP perceives parental fear as a barrier	yes	74	0.0767	0.2542
	no	69		
GPs spending long time re informed consent with first-time parents	yes	70	0.0134	0.5350
	no	73		

Table 7.3: Final GP multivariate model for immunisation coverage

R-squared for model	0.54
Number of practices in model	98
Valid region	<.0001
Social deprivation	<.0001
Age as a continuous variable	<.0001
Valid Māori governance	0.0394
GP knowledge (re fever)	0.0182
GP confidence in knowledge	0.0380

Table 7.4: The association of GP characteristics with immunisation timeliness at the practice

GP characteristic		**Median practice coverage %**	**P value Univariate**	**P value Adjusted***
GP perceives parental access difficulties as a barrier	yes	61	0.2002	0.0175
	no	52		
GP correct that fever not a contraindication	yes	60	0.5395	0.0583
	no	51		
GP confident in knowledge about immunisation	yes	59	0.1685	0.0757
	no	51		
GP correct knowledge about leukaemia as contraindication	yes	61	0.0412	0.1143
	no	49		
GP strongly agreed that practice teamwork was strong	yes	91	0.1676	0.1192
	no	56		
GP using immunisation handbook once a month or more	yes	49	0.0042	0.1330
	no	60		
GP correctly identifies what CARM stands for	yes	50	0.0050	0.1349
	no	65		
GP perceives parental apathy as a barrier	yes	57	0.1167	0.1752
	no	56		
GP perceives parental fear as a barrier	yes	59	0.0360	0.6271
	no	54		
GPs spending long time re informed consent with first-time parents	yes	57	0.1443	0.6675
	no	58		

7.3.2.4 Discussion

There were some limitations with this study. Firstly, it is only a survey of GPs in two regions and while they were a good match on our demographics with GPs nationally, it is still not nationally representative. Secondly, the findings are based on the practice, not the individual levels, which may bias the results if not all GPs in the practice have similar knowledge, attitudes, or experience. Thirdly, the immunisation coverage measurement results are dependent on the quality of the data entry at the practice and it was unknown how accurate this was.

The strengths of the study were its use of a standardised measure of immunisation coverage and timeliness across practices and the effective random selection of one GP per practice.

There were some concerning results from this study. Firstly, that nearly 10% of GPs did not support the immunisation schedule starting at six weeks of age, which was consistent with our findings in our earlier study (12). Consistent with the earlier study was the finding that nearly a third of GPs would delay giving the MMR vaccine in a mildly unwell child. Also consistent with the earlier study, these results highlight the importance of the PN for the main resource support to the GP.

Overall, those GPs with both better knowledge and more confidence were in practices that achieved better timeliness of delivery of immunisation events. This supports our hypothesis that both confidence and knowledge base contributed to higher immunisation coverage levels. However, it is interesting to note that in many examples poor GP knowledge is not linked to reduced timeliness of immunisation delivery. We suggested this may be because generally it is the PN who does most aspects of the immunisation event delivery. We further proposed that timeliness of delivery is less driven by some aspects of knowledge levels and more likely to be related to the commitment at each interaction and taking advantage of opportunistic moments. Therefore, some GP gaps in knowledge may be more important than others, such as a reluctance to immunise mildly unwell infants.

GPs who perceived parental access was a problem also worked in practices with better immunisation timeliness of delivery. This suggests that the GPs who have a focus on the broader challenges for their communities do better with their childhood immunisation outcomes.

7.4 Practice Nurses

7.4.1 PN Study One

7.4.1.1 Background

In parallel with our 2002 study of GPs, we undertook a similar telephone survey of PNs, which was published in 2005 (13). Our aim was to understand the immunisation issues confronting PNs in NZ. This study was also funded by a grant from GSK. GSK has no involvement in the study design or delivery. Helen Petousis-Harris was the Principal Investigator and again, we worked closely with Felicity Goodyear-Smith and Ben Soe on this project. Ben was engaged particularly on the data analysis and interpretation. We employed the project manager, Jenny Wilmshurst and Janet Brown, who undertook the interviews. My role was in the instigation of the project, accessing funding, and with Helen and Felicity we designed, oversaw the data collection and were all involved in the analysis, discussion, and conclusions.

7.4.1.2 Methods

The methodology was a CATI telephone survey, using a triangulation, multi-method investigation as outlined in 7.3 and the two studies ran in parallel over the same period of 2002/2003. Refer 7.3 for fuller details of the methodology. This study focused on PNs nationally and used the same national practice list as for the GPs. The researcher continued contacting random practices until 150 nurses had been recruited. All PNs working full-time or part time and actively involved in immunising children were included.

7.4.1.3 Results

A total of 199 randomly selected practices were contacted to reach a sample of 150 PN participants. Of the other 49, 31 PNs did not meet the inclusion criterion. Of the remaining, five declined and 12 requested a call back, but were unable to be scheduled within the study time frame. Therefore, overall participation was 89% (150/168). Almost all of the participants were female (148/150) and 78% were 40 years and older, although 84 (56%) had been in general practice work for less than ten years. Fifty percent worked part-time (defined as less than thirty hours) and 87 (58%) had pre-school or school-aged children.

PN perceived barriers to immunisation

The most frequent barrier perceived by a PN was parental fear, with 69% of PNs identifying this as the most significant barrier to immunisation uptake. PNs did not see access to services as a significant barrier. The strongest theme to emerge was the perception that there was parental lack of information or there was misinformation, particularly misinformation supplied by midwives. Cultural and language barriers, particularly for Māori and Pacific families, were a second theme. The third theme identified was parental apathy to following up for the immunisation events. The challenges with tracking transient families and the lack of a national register to follow them up were also identified as barriers. Refer Table 7.5.

Table 7.5: PN perceived barriers to improving childhood immunisation rates

Barrier	Agree n (%)	Neither agree nor disagree n (%)	Disagree n (%)
Parental fear regarding immunisation	103 (68.7)	17 (11.3)	30 (20.0)
Lack of funding for providers	31 (20.6)	11 (7.3)	108 (72.0)
Lack of time for providers to offer services	24 (16.0)	10 (6.7)	116 (77.3)
Patient difficulties accessing services	22 (14.7)	11 (7.3)	138 (92.0)
Lack of knowledge in health professionals	7 (4.7)	5 (3.3)	117 (78.0)
Lack of interest in the topic by providers	4 (2.7)	6 (4.0)	140 (93.3)
Poor MoH direction	4 (2.7)	6 (4.0)	140 (93.3)

PN knowledge

There were significant gaps in their knowledge with 35 (23%) believing that fully breastfed babies either always, or sometimes, receive specific protection against pertussis and 10 (7%) believing fully breastfed infants receive specific protection against measles. Overall, 12 (8%) felt that six weeks was too young to start immunising and a further 20 (13.3%) considered that this was sometimes too young. Refer Table 7.6. Despite the knowledge gaps, they did not tend to view their own lack of knowledge as a barrier to immunisation coverage. Most participants (138, 92%) disagreed with the statement that lack of knowledge was a barrier to immunisation, with 98 (65%) totally disagreeing. This was significantly more likely to be held by younger nurses, under 40 years ($\chi^2 = 5.56$, $p = 0.0184$).

The nurses were further categorised into those who had completed vaccinator training within two years, and those who had trained more than two years ago or not at all. Their mean number of correct answers to questions regarding contraindications for MMR and pertussis vaccines indicated that those who had received training over two years prior to the survey, or had never attended a course, were significantly less likely to give correct responses (Bartlett's $\chi^2 = 7.1077$, 1 df, p = 0.0077). When the type of course attended was analysed, those that had attended an update course, rather than a base course, scored significantly better ($\chi^2 = 4.79$, p = 0.029). When the nurses were categorised according to the immunisation coverage rates within their child patient population, those with practices with the highest coverage rate (≥95%) had a significantly higher mean number of correct answers than those with the lowest coverage rate (<70%) (Bartlett's test p = 0.0034).

Table 7.6: PN perceived contraindications to MMR and pertussis-containing immunisations

	Correct answer n	**Rate (%)**
Perceived contraindication to MMR vaccination		
Baby being treated for leukaemia*	50	33.3
Baby gets a rash eating eggs	65	43.3
Baby has spina bifida and hydrocephalus	84	56.0
Mother pregnant	114	76.0
Baby had a febrile convulsion at 11 months	119	79.3
Baby with snuffly cold	122	81.3
Baby reported to have had measles	123	82.0
Sibling has ADHD, Autism or Aspersers	128	85.3
History of parental febrile fits	129	86.0
Mother breastfeeding	140	93.3
Baby has eczema	142	94.7
Perceived contraindication to pertussis vaccination		
Baby had an HHE following previous immunisation	25	16.7
Screaming for more than 3 hours after the previous immunisation	39	26.0
Baby had apnoea in first 3 weeks	92	61.3
Baby has spina bifida, no leg weakness	103	68.7
Perceived contraindication to pertussis vaccination		

	Correct answer n	Rate (%)
Baby has motor delay*	109	72.7
Baby has a nasal discharge	116	77.3
Other sibling had fever following DTaP	146	97.3
History of parental febrile fits	141	94.0
Baby has eczema	141	94.0
Sibling has eczema or asthma	148	98.7

** = correct statement*

PN confidence

To explore whether confidence influenced vaccine coverage, all participants were categorised into two groups according to their level of confidence regarding their knowledge of immunisation. One hundred and twenty-seven nurses (85%) were very comfortable or comfortable about their knowledge on immunisation, and 23(15%) nurses were neither comfortable nor uncomfortable about their immunisation knowledge. Nurses with practices with immunisation coverage < 90% and ≥90% were compared. No statistical significance was found between the two groups ($\chi^2 = 0.06$, $p = 0.813$).

Information sources and education needs

All respondents used the MoH Immunisation Handbook as the major source of further information, and 93% utilised the services of their local immunisation coordinator. Other sources used included Ministry leaflets, colleagues and the services of IMAC.

Education needs that were most commonly identified were 99 (66%) wanting further information to counter misinformation, 73 (49%) more information on new vaccines, 59 (39%) more support with methods for obtaining informed consent and answering parents' concerns, 44 (29%) wanting more knowledge of the vaccines, and 41 (27%) more knowledge of vaccine side effects, 32 (21%) wanting more knowledge around the NZ immunisation schedule, 27 (18%) more knowledge of the diseases, and 24 (16%) more knowledge around delivery techniques. There were also some expressed needs for easy access to immunisation schedules from other countries.

7.4.1.4 Discussion

This was the first NZ survey of PNs on their views and knowledge around childhood immunisations. The results were very similar to the GP study undertaken concurrently (12) – refer 7.3. As with GPs, the majority of PNs identified parental concerns over immunisation safety as the most significant barrier to immunisation coverage. Further, they identified a need for more resources to help address misinformation that parents accessed, to offer more information about the risks and benefits of immunisation to assist parental confidence in their decision making.

While there were many gaps in PN knowledge, the majority did not identify this as a concern or barrier to immunisation uptake. The more recently trained PNs and those with the best practice coverage rates were more likely to give accurate answers on vaccine contraindications. This would support the international data at the time that suggested knowledge, rather than attitudes, is the most significant factor in immunisation uptake (88,206,211,212). It also supports the place of vaccinator training as an effective tool in improving immunisation coverage. The PNs' confidence in their own knowledge of immunisation did not appear to have any association with immunisation coverage rates.

7.4.2 PN Study Two

7.4.2.1 Background

As part of a larger HRC funded study discussed above, that looked at the contribution of all the different aspects of the general practice to immunisation uptake with the childhood vaccines we were able to undertake further research on PN knowledge and attitudes and the association with timeliness of immunisation delivery at the general practice level (22). The same team was involved as for the GP study; and for the PN study, Natalie Desmond, a member of the IMAC team at the time, undertook to lead the PN study as a part of her Masters in Nursing degree. The aim of this study was to explore characteristics, behaviours, attitudes, and knowledge of nurses working in the general practice setting that may influence the completeness and timeliness of childhood immunisation delivered by the family practice.

7.4.2.2 Methods

The knowledge and attitudes of nurses were elicited using a CATI with one randomly-selected nurse from each practice. Nurse knowledge and attitudes were measured using a questionnaire previously used in NZ (13) adapted from a UK questionnaire (186). The interview included demographics, (age, gender, length of time in general practice and working hours), their views on barriers to childhood immunisations, educational needs, knowledge of vaccine safety and contraindications, attitudes, resources available, and immunisation education of parents. The interviews lasted approximately 20 minutes with answers entered directly into the database for collation and analysis. Quantitative responses included yes/no answers, Likert scales and multi-choice options based on the questionnaire previously developed by us in our 2002 study (11). Refer 7.3 for the methodology for the full study.

7.4.2.3 Results

From the full randomly-selected practice sample, four practices did not have nurses, and two nurses covered two practices each. One nurse from each of 115 of the remaining 124 enrolled practices was interviewed. Nurses from three practices declined to participate. Refer Figure 7.3 for how the dataset was obtained.

All participants were female, 67 were from Auckland and 48 from the Midland region. The majority were aged 40 and over (n=79, 69%) and nearly a half (n=47, 41%) had been working as PNs for 10 to 19 years. This matched the NZ profile of NZ primary health care nurses from the MoH database of 1998: >95% female, tending to be an older group than the national nursing workforce (68% ≥ 40 years) and over a third have been working as primary care nurses for 10 to 19 years (213).

Seventy two (63%) of the nurses had dedicated time to spend on immunisation follow-up and almost all (109; 95%) were exclusively responsible for delivery of immunisations. Forty-six (40%) immunised 11 to 20 children per month and 31 (27%) immunised 21 to 50 children.

The number of registered children under the age of two per full time equivalent nurse varied widely across the 124 practices, ranging from 0 to 290 children (mean = 60) per nurse.

Nurses' preferred source of information on immunisation (n=111; 97%) was the MoH Immunisation Handbook. Most nurses (n=100; 87%) would seek further information from other PN colleagues, and 89 (77%) would go to GP colleagues for information. The most frequent request for information was that relevant to current issues in the media (n=89; 77%).

Almost all nurses (100; 96%) felt comfortable with their immunisation knowledge. Despite this, significant knowledge gaps were shown. With respect to contraindications to measles, mumps, rubella (MMR) and pertussis vaccines, 61 (53%) correctly identified that a rash after eating eggs was not a contraindication to MMR immunisation, 23 (20%) stated they would delay MMR if the child had rhinorrhoea and low grade fever. Only 44 (38%) identified correctly a previous HHE, and 60 (52%) that prolonged screaming after a previous dose, were not contraindications to giving the pertussis vaccine.

There was a wide variety of opinions on views around barriers to patients accessing services. Parental apathy or ambivalence was considered a barrier by 58 (47%) and parental fear by 68 (59%). Of the 77 nurses who offered other suggestions, 22 (30%) considered anti-immunisation misinformation to be a significant barrier for parents.

After adjustment for region, Māori governance, social deprivation of the practice population and median age of the children registered at each practice, there were four significant associations with higher rates of timely immunisation delivery: (1) a lower ratio of nurses to children registered with the practice (P = 0.03);(2) nurse perception of parental apathy (P = 0.005); or (3) fear (P = 0.008) as a barrier; (4) PN comfort in her knowledge about immunisation (P = 0.0004). When further adjustment was made for these same four variables, a lower ratio of nurses to children registered with the practice (P = 0.007), nurse perception of parental apathy as a barrier (P = 0.003) and her comfort in her knowledge about immunisation (P = 0.049) were associated with more timely practice immunisation delivery. Refer Table 7.7.

Table 7.7: Associations with PN characteristics and immunisation timeliness of delivery at the practice level

Variable (number of practices)	**Median practice immunisation coverage (25th, 75th centile)**				**P value**
Region	**Auckland……………….**		**Midland**		
Governance	Māori n = 7	Non-Māori n = 61	Māori n = 14	Non-Māori n = 36	
Practice infrastructure relevant to delivery by nurses					
Ratio of PNs to children (115)					
1:1 to 1:74 (85)	37 (30, 46)	60 (47, 68)	44 (25, 57)	59 (47, 63)	0.007
1:75 to 1:1290 (30)	17 (17, 17)	52 (44, 66)	36 (31, 40)	61 (56, 64)	
Nurses attitudes					

Variable (number of practices)	Median practice immunisation coverage (25th, 75th centile)				P value
Region	Auckland………………		Midland		
Perceives parental apathy as a barrier to immunisation (109)					
Yes (56)	47 (47, 47)	60 (49, 68)	50 (36, 60)	60 (49, 63)	0.003
No (53)	23 (17, 32)	55 (40, 66)	42 (28, 54)	58 (36, 66)	
Nurse knowledge					
Comfortable with own level of knowledge (109)					
Yes (105)	28 (20, 40)	59 (44, 66)	44 (28, 57)	59 (47, 63)	0.05
No (4)	-	76 (11, 78)	-	47 (47, 47)	
A cold is not a contraindication (107)					
Yes (83)	23 (17, 32)	58 (43, 66)	44 (28, 50)	60 (47, 64)	0.10
No (24)	47 (47, 47)	65 (49, 75)	62 (40, 67)	58 (35, 61)	
Completed a vaccination training course (109)					
Yes (102)	23 (17, 47)	58 (44, 66)	43(25,52)	59(47,63)	0.09
No (7)	32 (32, 32)	69 (58, 75)	64 (64, 64)	58 (58, 58)	

In the multivariate analysis, four nurse factors remained independently associated with higher practice immunisation coverage: Firstly a lower ratio of nurse to children in the practice (p = 0.04); Secondly nurse perception of parental apathy (p = 0.01) or thirdly fear (p = 0.01) being a barrier to immunisation and fourthly the nurse's comfort in her immunisation knowledge (p < 0.001). Refer Table 7.8.

Furthermore, in the multivariate models, the nurse specific variables accounted for an additional 12% of the variance in the coverage model and 11% of the variance in the timeliness model over and above that explained by region, practice governance, social deprivation and age of the children.

Table 7.8: Multivariate analysis of PN characteristics associated with immunisation timeliness of delivery at the practice level

	Association with coverage	Association with timeliness
R-squared for model	0.54	0.39
Number of practices in model	98	100
Region	<.0001	0.102
Social deprivation	<.0001	<.001
Median age of children registered at the practiced	<.0001	NS
Māori practice governance	0.039	0.056
Ratio of nurse to children in the practice	0.04	0.03
Nurse perceives parental apathy as a barrier to immunisation	0.01	0.02
Nurse perceives parental fear as a barrier to immunisation	0.01	-*
Nurse comfortable with own level of knowledge	<0.001	0.01

7.4.2.4 Discussion and recommendations

This study was consistent with the literature that the role of the front line health care professional is critical to obtaining high immunisation coverage levels. There are some limitations to this study (14). The major one was that interviewing only one PN may not reflect the views of all the PNs in the practice, and the outcome measures are based on the full general practice results. The strengths of this study is the high rate of participation, with only three PNs declining to participate, and the use of an independent standardised measure for practice immunisation coverage and timeliness.

The NZ PN population is a slightly older, more experienced, and mostly highly trained group of professionals than the general nursing population. An important finding here was that nurse confidence in her immunisation knowledge is a predictor of better practice immunisation. While it is hard to be clear how important is the actual knowledge level and how important is the degree of confidence in their knowledge, clearly the mixture of both is important. Despite their confidence, similar to NZ GPs (21), significant gaps in their knowledge base still remain. This supports the findings from our earlier study around the importance of vaccinator training and on-going education to support PNs to deliver effectively and confidently (13).

In terms of PN resource needs, again the role and importance of the MoH produced Immunisation Handbook stands out for all front line HCPs as the primary resource. The role of both PN and GP colleagues are the next more significant resource. The GP and PN can be seen very much as a team in the general practice setting in many aspects of the immunisation service delivery.

A further significant finding was the PNs who perceived parental barriers of apathy and/or fear as being a barrier to improving immunisation uptake. While it is not entirely clear what are the drivers behind this finding, we felt that PNs with these perceptions may be more engaged in the issue, and therefore may take more proactive action and more attention to parental needs.

The final significant result was the importance of enough PNs, and PN time. As PNs are the front line health professionals delivering the childhood immunisation programme, a focus on giving them enough time and resourcing to undertake the role is paramount and highlighted here.

We concluded that nurses may be considered the immunisation leaders in many practices, where their knowledge is sought after; they administer almost all childhood immunisation and invest a substantial amount of time with caregivers (22). We stressed the importance of investing well in nursing staff by particularly focusing on the nurse to child ratio in the practice as a quality practice management measure. We recommended further research to support better resources for nurses, to further understand and communicate immunisation issues to their patient group more effectively.

7.5 GPs and PNs: Comparing and contrasting

7.5.1 Background

Recognising that both GPs and PNs were the crucial front line HCPs involved in the delivery of the childhood immunisation programme, we decided to explore further the similarities and differences between the two groups.

To undertake this study, we used the data we had already collected from the CATI studies with GPs (12) and PNs (13). The aim of this study was to understand, compare, and contrast the immunisation issues confronting these two different professional groups. This study was led by Felicity Goodyear-Smith and published in 2005 (14).

7.5.2 Methods

For this study the data that were collected from GPs and PNs CATI interviews from the earlier studies on the determinants of health, as described in 7.3.2 and 7.4.2, was utilised. These data were converged using a triangulation, multi method approach to understand and compare immunisation issues confronting GPs and PNs.

7.5.3 Results

Barriers to immunisation

Both GPs and PNs identified parental fear as the most important barrier, although this was identified by significantly more PNs than GPs ($\chi^2 = 7.412$; df=1; p=0.006). GPs were significantly more likely than PNs to identify lack of funding for providers (χ^2=18.66; df=1; p<0.001.); lack of time for providers to offer services (χ^2=6.29; df=1; p=0.012); poor MoH direction (p<0.001) and lack of interest in the topic by providers (p=0.002) as barriers. Refer Table 7.9.

Very few GPs (8%) or PNs (5%) identified their own lack of knowledge as a major barrier. A minority of GPs (13%) and PNs (15%) thought patient access to services was a problem.

In the qualitative analysis, the most important theme from the GPs was concerns around parents being given negative information, particularly from the anti-immunisation lobby groups and midwives.

Table 7.9: Perceived barriers to improving immunisation

Agreed barrier	GP n (%)	PN n (%)	p
Parental fear regarding immunisation	80 (53)	103 (69)	0.006
Lack of funding for providers	66 (44)	31 (22)	<0.001
Lack of time for providers to offer services	42 (28)	24 (16)	0.012
Poor MoH direction	41 (27)	4 (3)	<0.001
Patient difficulties accessing services	20 (13)	22 (15)	0.739
Lack of interest in the topic by providers	17 (11)	4 (3)	0.002
Lack of knowledge in health providers	12 (8)	7 (5)	0.236

NB more than one barrier could be identified by respondents

Practitioner knowledge and educational needs

More than a third of GPs and PNs would not give MMR to a child who had an egg allergy and about 20% of both GPs and PNs incorrectly believed that MMR should not be given if a child has a snuffly nose. Significantly more PNs than GPs knew that apnoea in the first three weeks of life, screaming for more than 3 hours or an HHE event after a previous vaccination were not vaccine contraindications. Only about one third of GPs felt that their knowledge on vaccines, side effects, and the NZ schedule needed updating (33 to 38%), and the PNs were even more confident in these areas, with only 21 to 27% considering they needed their knowledge updating. Refer Table 7.10.

Overall, 11% (n=16) of GPs and 21% (n= 32) of PNs considered six weeks too young or sometimes too young to start immunising an infant.

Table 7.10: Answers to perceived contraindications to receipt of MMR and pertussis-containing vaccines by GP and PN

Correct answer rate	**GP** **n (%)**	**PN** **n (%)**	**p**
Perceived contraindication to MMR vaccination			
Infant being treated for leukaemia*	84 (56)	50 (33)	<0.001
History of parental febrile convulsions	145 (97)	129 (86)	0.002
Infant has eczema	143 (95)	142 (94)	0.980
Infant reported to have had measles	137 (91)	123 (82)	0.017
Mother breast feeding	133 (89)	140 (93)	0.158
Sibling has ADHD, Autism or Aspergers	122 (81)	128 (85)	0.353
Infant with snuffly cold/nasal discharge	119 (79)	122 (81)	0.663
Infant has a febrile convulsion at 11 months	110 (73)	119 (79)	0.222
Mother pregnant	99 (66)	114 (76)	0.056
Infant has spina bifida and hydrocephalus	72 (48)	84 (56)	0.166
Infant gets a rash eating eggs	54 (36)	65 (43)	0.194
Perceived contraindication to pertussis-containing vaccine			
Infant had motor delay*	97 (65)	109 (73)	0.135
Sibling has eczema or asthma	150 (100)	148 (98)	0.498
Infant has eczema	146 (97)	141 (94)	0.256
History of parental febrile convulsion	145 (97)	141 (94)	0.256
Older sibling had fever following pertussis- containing immunisation	141 (94)	146 (97)	0.256
Infant with snuffly cold/nasal discharge	127 (85)	116 (77)	0.105
Infant has spina bifida, no leg weakness	97 (65)	103 (69)	0.462
Infant had apnoea in first 3 weeks of age	75 (50)	92 (61)	0.048
Screaming for >3 hours after previous immunisation	58 (39)	39 (26)	0.019
Infant had an HHE following previous immunisation	9 (6)	25 (16)	<0.001

** = a genuine contraindication*

Large numbers of GPs and PNs were keen to have more information on current immunisation issues (66% in both groups). Refer Table 7.11. They also wanted more support for obtaining informed consent and answering parental concerns. This was significantly more important to GPs than PNs (56% compared with 39%, χ^2 = 8.35, df1, p=0.004). GPs were also more interested in information on new vaccines than PNs.

In the qualitative analysis both GPs and PNs were particularly concerned and requesting resources to dispel parental fears. A second area of need identified was further international information, including easy access to immunisation schedule from other countries, to facilitate immunisation updates for immigrant children.

Table 7.11: Identified educational needs

Topics on which the practitioner wanted more information	GP n (%)	PN n (%)	p
Current issues reported in the media	99 (66)	99 (66)	1.0
New vaccines	102 (68)	73 (49)	<0.001
Support with methods for obtaining informed consent and answering parental concerns	84 (56)	59 (39)	0.004
Knowledge of the vaccines	49 (33)	44 (29)	0.533
Knowledge around vaccine	57 (38)	41 (27)	0.049
Knowledge around the NZ immunisation schedule, and rationale behind it	50 (33)	32 (21)	0.020
Knowledge around delivery techniques	41 (27)	27 (18)	0.054

7.5.4 Discussion and recommendations

The study was unique in that, for the first time, there was information in this area from a nationally representative group of GPs and PNs. A limitation of the study was that it was entirely based on self-reported measures, which may not translate directly to actual clinical practice.

There was a significant amount of agreement between GPs and PNs regarding what they perceived as the main barriers to childhood immunisation uptake. Both groups considered the most significant barriers were parental fear and misinformation being given to parents. This is consistent with our research with NZ parents, who were expressing the same concerns (9).

GPs were significantly more likely than PNs to identify lack of funding as a barrier. This is no surprise given that GPs are more likely to be in ownership or governance roles in general practices where they need to meet the costs of service delivery.

In common, GPs and PNs did not consider patient difficulties in accessing services a significant barrier to improving immunisation uptake. This was in contrast with the NZ strategy at the time that was focused predominantly on structural barriers to accessing services as outlined in Chapter 2 (55).

GPs and PNs in general showed a poor knowledge of vaccine contraindications, as illustrated with MMR and pertussis-containing vaccines. Despite this, they did not rate their knowledge as an important factor in low immunisation coverage, nor did the majority of them feel they needed further knowledge. We reported this as being a particular area of concern as misinterpretation of vaccine contraindications is very likely to lead to under immunisation and missed opportunities to immunise. In particular, it was of significant concern that approximately one fifth of all GPs and PNs reported that a ‘snuffly nose’ is a contraindication to receiving the MMR immunisation. We saw this as of considerable concern and needed greater attention in education and

CME opportunities. PNs were more knowledgeable about some contraindications than GPs, in particular around infant apnoea and HHEs not being contraindications and this is likely to reflect vaccinator training that included PNs, but not GPs.

This study also confirmed the findings of a local Rotorua study at the time that indicated that some GPs and PNs continued to lack confidence in vaccine safety, although at much lower rates than other health professional groups (185).

Of significant concern also was the group of just over 10% of GPs and over 20% of PNs who felt that six weeks may be too young to start immunising. This misinformation clearly required further attention, as it has the potential to significantly affect timeliness of delivery.

Both GPs and PNs expressed a strong desire for more effective user-friendly, evidence-based resources to more effectively communicate with parents and caregivers.

In conclusion, we recommended both the need for better informed consent tools for practitioners, and a greater focus on education particularly around misunderstandings about starting at six weeks of age and contraindications.

7.6 Chapter conclusions

While obtaining high immunisation coverage is multifactorial, the role of the HCP is likely to be a major factor, both their knowledge base and their attitudes. In the NZ context, the highest priority HCP in vaccine delivery is the GP/PN team. Historically NZ had no local research on this topic.

Perceived barriers to immunisation

The research I have undertaken since 2002 with my colleagues that is discussed in this chapter, has highlighted firstly, that both GPs and PNs had similar opinions as to what they see the barriers for parents are in obtaining immunisation for their infants. The first and most prominent theme was parental fear and being given misinformation, particularly in the antenatal period and often through the media. The second theme followed this and was a perceived lack of resources, both for parents and for themselves, to be able to effectively respond to misinformation. A further theme was from those practices that had very mobile populations and the difficulties in tracking and offering services to these populations. Interestingly, this was not seen as an access to services barrier by most, and even less so by rural practices. A further theme identified by GPs was the lack of funding for the services offered. With PNs, the importance of having enough time and resourcing to focus on all the necessary parts of the delivery process was clearly demonstrated.

HCP knowledge

For both GPs and PNs there were significant gaps in their knowledge base. However, many of these did not appear to translate through to affecting immunisation coverage. In general, it appears that HCP confidence is overall the more important factor, although this does require an adequate level of knowledge. Those who felt both confident and that they were knowledgeable, despite being unaware of some gaps in their knowledge, still were able to engage and effectively immunise. HCPs who perceived parental access or apathy to be a barrier appeared to be more engaged and more proactive in obtaining high immunisation coverage for their registered population, once again highlighting the importance of an engaged and committed HCP.

An important knowledge area that was likely to affect immunisation uptake was that a minority would chose to delay immunising an infant due to a minor illness (allowing for more missed opportunities to immunise). This area of research I have followed through further and is described in Chapter 8. Of further significant concern was the important 10% of GPs and over 20% of PNs who felt that six weeks may be too young to start immunising. Since this finding, IMAC has been able to use many opportunities in vaccinator training, updates, GP teaching, media and public presentations to explain the infant immune system to reduce this fear.

The major source of information at this time was the MoH Immunisation Handbook, clearly a key tool for vaccinators and information givers. However, of interest was also the importance of colleagues, both within the practice and immunisation coordinators.

Impact on policy

We have been privileged to be able to use this research data usefully to support the NZ strategic direction since this time. Changes that have been instituted in NZ, supported by our research both with parents and HCPs, have included enhanced support to the IMAC services, which now runs a national 0800 line for both parents and HCPs, associated with a very active information dissemination and media management service. Informed consent processes have been supported with the development of a tool *In The Loop* for the HCP to use with the parent/patient. More attention has also been given from the MoH and DHB level to the antenatal period with increased HCP education and resourcing and a strong focus on early enrolment to support the general practice team engagement with the family as early as possible.

In conclusion, these studies highlighted the critical role of the PN and GP, the need for extra resourcing and support in specific areas, and particular gaps in their knowledge base. All of these findings have been reported back and used in a range of on-going strategic approaches in the NZ strategy since publication of these papers.

7.6 Summary of Chapter 7

This chapter focused on the role of the HCP as a major contributory factor associated with childhood immunisation coverage. It presents the research I have undertaken with colleagues around the front line HCP in immunisation service delivery, GPs and PNs, over the period from 2002 to 2005. This research explored their perceived barriers to parents obtaining childhood immunisation at the general practice level, their knowledge, their attitudes and their further resourcing needs. The research explores GP and PN issues both separately and then compared and contrasted.

CHAPTER 8 THE CONTRIBUTION OF HEALTHCARE PRACTICES TO CHILDHOOD IMMUNISATION COVERAGE

8.1 Outline of Chapter 8

International literature identifies that the most significant barriers to immunisation coverage are related to family poverty factors, service delivery systems, healthcare provider and family and child factors (194). This chapter looks at provision by the healthcare service delivery. The aim is to present and discuss the published research I have undertaken with colleagues since 2004 focusing on NZ healthcare service provision and, in particular, the front line service provision at the general practice level and how this can impact on immunisation coverage and timeliness of delivery for the childhood immunisation programme.

The research I have presented so far on the factors affecting immunisation coverage has focused on characteristics related to parents, broader environmental issues, and front line healthcare providers (HCPs). An essential component to effectively immunising is the many components of the health system itself, beyond just the characteristics of the HCPs. This chapter focuses on systems, in particular the systems at the general practice level that contribute to effective and timely immunisation service delivery. As outlined in the literature review in Chapter 3 effective delivery at the provider level has the strongest evidence for obtaining high immunisation coverage. Important aspects of service delivery include effective use of systems for data collection, analysis and feedback, good enrolment, engagement and continuity of care, effective recording, use of registers, identification and recall systems, and appropriate resourcing (130,137).

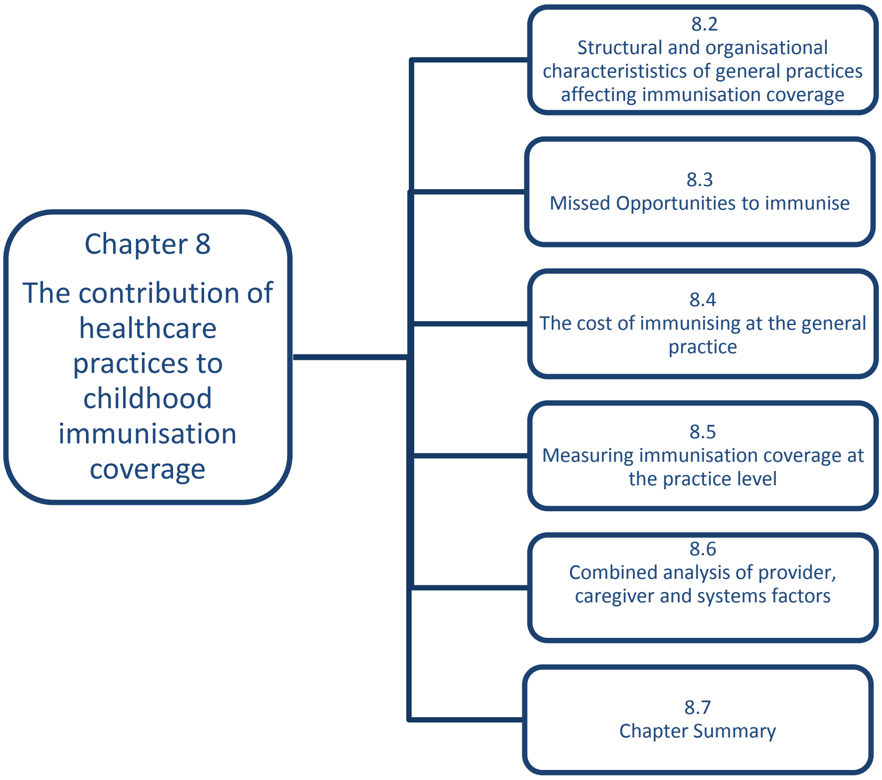
Chapter 8
The contribution of healthcare practices to childhood immunisation coverage
8.2
Structural and organisational characterististics of general practices affecting immunisation coverage
8.3
Missed Opportunities to immunise
8.4
The cost of immunising at the general practice
8.5
Measuring immunisation coverage at the practice level
8.6
Combined analysis of provider, caregiver and systems factors
8.7
Chapter Summary

Figure 8.1: Outline of Chapter 8

8.2 Structural and organisational characteristics of the general practice associated with immunisation coverage rates

8.2.1 Introduction

As outlined in 7.3.2, in 2004 I was part of a team that designed and undertook a study looking at the characteristics of the healthcare practices and providers that immunise in NZ. Our overall aims were to identify the characteristics that were associated with those practices that achieved higher immunisation rates and better timeliness of delivery. The study was funded by an HRC grant. The Principal Investigator for the study was Associate Professor Cameron Grant. The core members of the research team were Cameron, myself, Felicity Goodyear-Smith and Helen Petousis-Harris. Dr Rhys Jones supported particularly with the Māori aspects of the project, Ngaire Kerse particularly with recruitment and advice on study design, Joanna Stewart gave analytical statistical support, Jackie Copp managed the project, and Deon York was the research assistant.

The aim of this component of the study was to determine the structural and organisational characteristics of general practices that are associated with higher immunisation coverage and better timeliness of delivery for the infant schedule. There are four publications arising from these results (23,24,25,214,).

8.2.2 Methods

Practice structure and organisation were defined as those aspects of the practice that were independent of the characteristics of a specific GP or PN, but were liable to influence the care they delivered when working within the practice (23) we divided them into:

I. Those factors that were relevant to all aspects of primary care delivery e.g. type of governance of the practice, age of registration of a child, and staffing issues.
II. Those factors that were specific to immunisation delivery e.g. specific immunisation clinics, and which HCP delivered the vaccines.

Refer Chapter 7.3.2 for the outline of the methodology. The practice structure and organisation were described via a face-to-face interview with the practice manager, lead GP or senior PN. Practice population demographics were obtained from the MoH. Collection of practice immunisation coverage records is described in 7.2.2.

The data analysis is described in Grant et al 2010 (23). The analysis was fully undertaken by Cameron Grant, I did not have involvement in this - and the description of this below is provided by Cameron:
The proportion of children fully immunised and those with no delayed immunisation was transformed to facilitate analysis using the arcsin of the square root of the variables. This transformation was undertaken to make the variance constant across the distribution of coverage, and the number of children at each practice. A general linear model was created with the arcsin of the square root of the proportion immunised as the outcome variable. A regression analysis was undertaken by creating a base model that included the explanatory variables of region, practice governance, socioeconomic deprivation, the child's age, and age at registration. Additional explanatory variables that described practice structure and organisation were then added to the model. Practice structure and organisational variables were retained in the final models of coverage and timeliness if they

increased the model’s explanatory power or remained significantly associated with coverage or timeliness at the practice.

Immunisation coverage was measured based on the child’s age in relation to the immunisation schedule. Immunisation coverage was defined using the third dose assumption as discussed in 7.2.2. Timeliness of delivery was defined as delayed receipt of an immunisation event if not received within four weeks of the 6 week event and within six weeks of the 3 month, 5 month, and 15 month events.

8.2.3 Results

A total of 124 practices were recruited and analysed for practice characteristics. Chapter 7, Figure 7.3 summarises the data sets used in this study.

Factors related to geography, practice governance and demographics

Factors relating to geography, practice governance and funding, population socioeconomic deprivation and age of the registered child are show in Table 8.1 which is reproduced from Grant et al 2010 (23). Practice coverage was higher in the Midland region than Auckland (median percentage 73% versus 68% fully immunised). There was no variation with rural to urban. Practice immunisation coverage ($p < 0.001$) and timeliness ($p = 0.002$) both significantly decreased as the socioeconomic deprivation of the registered practice population increased. Immunisation timeliness was lower for those practices that were under Māori governance than non-Māori governance ($p = 0.03$). There was no difference by type of practice funding. Younger age of the child at registration was associated with higher immunisation coverage ($p = 002$) and more timely immunisation delivery ($p = 0.02$). Immunisation coverage decreased with increasing age of the child ($p<0.001$).

Table 8.1: Associations of region, practice governance, socioeconomic deprivation, child's age and child's registration age with practice immunisation coverage and timeliness

	Immunisation coverage			**Immunisation Timeliness**		
Practice characteristic (number of practices)	Median % (25 –75th centile)	Unvariate P value	Multivariate P value[a]	Median % (25 – 75th centile)	Unvariate P value	Multivariate P value[a]
Region: Auckland (68) Midlands (50)	68 (53 – 75) 73 (58 - 79)	0.020	0.004	55 (41 – 66)	0.250	0.350
Practice governance: Māori (21) Non-Māori (97)	56 (44 – 62) 73 (63 – 79)	0.006	0.110	40 (25 – 47) 59 (47 – 66)	0.002	0.030
% registered patients in most deprived quintile[b]: <30% (86) ≥30% (32)	74 (63 – 79) 58 (35 – 65)	<0.001	<0.001	60 (47 0 66) 42 (25 – 58)	< 0.001	0.002
Median age registered children at each practice <13 months (48) >13 months (70)	73 (65 – 78) 64 (49 – 77)	0.001	<0.001	61 (54 – 66) 48 (34 – 63)	0.001	0.560
Median age of children at registration <3 months (72) ≥3 months (46)	74 (63 – 79) 63 (46 – 73)	0.040	0.020	60 (46 – 66) 47 (35 – 62)	0.140	0.020

a = adjusted for other variables in the table with socioeconomic deprivation, age and age at enrolment all entered into model as continuous variables

b = percentage in the most socioeconomically deprived quintile included in model as a continuous variable.

Factors related to practice organisational features

There were four major electronic PMSs used. The most commonly used was Medtech32 by 89 (76%) of practices. After adjustment for region, governance, social deprivation and age, immunisation coverage (p=0.001) and timeliness (p = 0.01) were both higher at practices that used Medtech32. Refer Table 8.2 which is adapted from Grant et al 2010 (23).

In total, 75 practices (65%) experienced staff shortages and these were associated with less timely immunisation delivery (p = 0.04).

Childhood immunisation visits were free at all practices. For other visits, practice charges ranged from free to $30 for children under six years of age and from free to over $60 a visit for adults. At 41 (35%) practices less than 5% of patients owed money, at 32 (28%) 5 to 15% owed money and at 43 (37%) more than 15 % owed money. In the univariate analysis, both immunisation coverage and timeliness of delivery were higher in practices where 15% or less of patients owed money. However, these associations did not remain after adjustment for socioeconomic deprivation.

Immunisation-specific organisational factors in the practice

There was considerable variability in how practices delivered immunisation specific services. In total, 40 practices (34%) had specific clinics or allocated appointments for immunisation. At 44 (38%) practices the GP sometimes gave immunisations. For 32 practices (27%), immunisation audits were completed at least monthly. After adjustment for region, practice governance, socioeconomic deprivation of the population, child’s age, and age at registration, none of these specific features were associated with coverage or timeliness.

Table 8.2: Associations of practice structure and organisation factors with practice immunisation coverage and timeliness

	Immunisation coverage			Immunisation Timeliness		
Practice characteristic (number of practices)	Median % (25 – 75th centile)	P value adjusted for region and governance	P value adjusted for region, governance, social deprivation[a], age and age at registration	Median % (25 – 75th centile)	P value adjusted for region and governance	P value adjusted for region, governance, social deprivation[a], age and age at registration
Generic practice factors						
PMS used:						
MedTech32 (89)	72 (62-78)	<0.001	0.001	59 (46 – 64)	<0.001	0.010
Other (28)	63 (44 – 76)			42 (25 – 60)		
Staff shortages						
Yes (76)	67 (53 – 75)	0.010	0.100	50 (37 – 63)	0.007	0.040
No (41)	76 (65 – 79)			61 (44 – 66)		
Practice charges for visits						
Yes (31)	75 (70 – 82)	<0.001	0.200	49 (35 – 64)	0.002	0.240
No (86)	65 (52 – 72)			61 (57 – 64)		
Percentage of patients owing money to practice						
>15% (43)	62 (47 0 73)	<0.001	0.270	47 (32 – 62)	<0.001	0.180
≤ 15% (73)	75 (65 – 80)			60 (47 – 66)		

	Immunisation coverage			Immunisation Timeliness		
Practice characteristic (number of practices)	Median % (25 – 75th centile)	P value adjusted for region and governance	P value adjusted for region, governance, social deprivation[a], age and age at registration	Median % (25 – 75th centile)	P value adjusted for region and governance	P value adjusted for region, governance, social deprivation[a], age and age at registration
Immunisation-specific practice factors						
Specified clinics or appointment for immunisation						
Yes (40)	69 (59 – 77)	0.030	0.270	57 (43 – 64)	0.050	0.430
No (77)	71 (57 – 77)			55 (38 – 64)		
GPs sometimes give the immunisations						
Yes (44)	70 (64 – 79)	0.110	0.580	60 (46 – 66)	0.020	0.200
No (73)	70 (54-75)			55 (32-62)		
Frequency of immunisation audit						
At least monthly (32)	72 (62-77)	0.005	0.250	58 (47-62)	0.070	0.900
Less often (85)	70 (56 – 77)			51 (37 – 65)		

[a] *= percentage in most socioeconomically deprived quintile included in the model as a continuous variable and using the NZDep2001 Index of deprivation.*

Multivariate analysis of characteristics

From the base model (region, practice governance, social deprivation of the registered population, child's age, and age at registration), the other variables were added. In the multivariate analysis, immunisation coverage varied by region (p = 0.002), was lower in practices with a more socioeconomically deprived population (p< 0.001), was higher in practices where children were registered at a younger age (p= 0.002), higher with practices that used Medtech as their PMS (p<0.001) or did not experience staff shortages (p= 0.027). Timeliness of delivery was lower in Māori governance practices (p = 0.020) and at practices where the registered population was more socioeconomically deprived (p <0.001). Timeliness was higher for practices with populations with younger children (p = 0.04), practices where children were registered at a younger age (p=0.007), practices that used MedTech32 as their PMS (p = 0.006), and at practices that did not experience staff shortages (p = 0.021). Refer Table 8.3 reproduced from Grant et al 2010 (23).

Table 8.3: Multivariate analysis of practice structure and organisation factors and their associations with practice immunisation coverage and timeliness

	Immunisation coverage[a]		Immunisation Timeliness[b]	
	Coefficient (95% CIs)	P value	Coefficient (95% CIs)	P value
Region: • Auckland • Midland	-0.091 (-0.147 to 00.036)	0.002	-0.029 (-0.083 to 0.026)	0.31
Practice governance: • Māori • Non-Māori	-0.073 (-0.155 to 0.001)	0.09	-0.096 (-0.177 to – 0.015)	0.02
% of registered patients in most socioeconomically deprived quintile	-0.003 (-0.004 to -0.001)	< 0.001	-0.003 (-0.003 to -0.003)	<0.001
Median age of registered children at practice	-0.001 (-0.001 to 0.000)	0.13	0.001 (0.000 to 0.001)	0.046
Median age of children at registration	-0.001 (-0.002 to -0.001)	0.002	-0.001 (-0,001 to -0,001)	0.007
PMS used	0.215 (0.105 to 0.342)	<0.001	0.154 (0.047 to 0.26)	0.006
Practice experiences staff shortages	-0.074 (-0.138 to -0.010)	0.027	-0.076 (-0.139 to -0.013)	0.02

a= data from 95 practices in multivariate model,r2 for model = 0.060.

b= data from 95 practices in multivariate model, r2 for model = 0.45

8.2.4 Conclusions

There are modifiable factors at the primary care level that make a difference to both immunisation coverage and timeliness of delivery. Those identified in this study include the early establishment of a relationship between the HCP team and the infant/family and having an adequately resourced practice with stable staffing, practice systems, and governance.

There are some limitations to this study. The response rate was 61% and there were even less numbers in the final multivariable models. At the time of this study, the meningococcal B mass vaccination campaign was being rolled out and, in the Midland region; many practices were involved in large practice accreditation processes. Both of these affected practices' ability to engage with the study. It is possible that the lower participation may have been from practices with lower coverage and explains the finding of higher immunisation coverage rates in the participating Midland practices.

8.2.5 Discussion

This study clearly demonstrated that immunisation coverage and timeliness of delivery are affected by characteristics at the general practice level. As demonstrated in Chapter 3, Table 3.1, it is well established that socioeconomic factors of the patients affect immunisation uptake. This was clearly demonstrated again here with social deprivation of the registered practice population being the dominant factor in the multivariate models.

The three significant practice characteristics that were associated with immunisation coverage and timeliness of delivery were (1) younger age of the infant at registration, (2) the type of PMS that the practice used and (3) staff shortages. None of the immunisation specific factors that we identified were associated with immunisation coverage or timeliness. Timely delivery of the first immunisation event has been well established as a strong predictor of completion of the immunisation schedule (193) and early engagement with the practice is very likely to facilitate a timely first event, hence the importance of the association with early age of registration with the practice. The differences by PMS are important to note and we assume that the ability to effectively use the practice system for functions, such as interface with the NIR data, entering and storing patient records, reporting, recalling, auditing, are all likely to affect immunisation coverage and effective recording of immunisation events. The team research assistant noted in the study that there was a lot of variation with staff competence and confidence in their ability to comfortably and effectively use the PMS. Hence we recommended that the type and use of PMS be afforded more attention for effective delivery. It is not a surprise that staff shortages are likely to affect immunisation delivery. A similar finding was seen in the PN study in that the ratio of PN to child makes a difference to the ability to deliver immunisation services. Practices with lower staff ratios or higher staff turnover are likely to find it more difficult to systematically deliver effective services. Staff shortages, however, also may reflect a service that is not so functional and may also be an indirect measure of a practice that is not effectively working as well as a team. Furthermore, staff turnover means loss of knowledge and the need for new staff to relearn or establish new systems, all of which is likely to impact on a systematic approach to service delivery.

8.3 Missed opportunities to immunise at the general practice

8.3.1 Background

Missed opportunities (MO) to immunise have been identified in the international literature as a significant factor contributing to incomplete immunisation. MOs are defined as visits to a healthcare provider, where children are age eligible for an immunisation event, have no contraindication present, and do not receive the immunisation at that visit (216). Missed opportunities are estimated to occur in 20 to 84% of all child health care visits (217) and contribute up to 40% of the total under-immunisation (218). As outlined in barriers to immunisation uptake in Chapter 3.2, MOs are likely to arise both through gaps in provider knowledge and attitudes and through gaps and lost opportunities with effectively utilising practice systems.

Recognising that MOs were highlighted as such a significant aspect of reduced immunisation coverage, I undertook a study on MOs to immunise at the general practice level as a thesis for completion of my Masters of Public Health, which was submitted in 2006 (63). The study was undertaken as a part of the larger study on the determinants of immunisation at the general practice level, as outlined above in 7.3. My supervisor was Cameron Grant. The aim of this study was to describe the frequency and characteristics of MOs to immunise within the NZ primary care setting and to estimate the contribution that MOs make to incomplete immunisation for the childhood immunisation programme. The study involved a patient record audit. I undertook the data collection with assistance from a research nurse, Nan McKenzie and Dr Rebecca Sommerville. Cameron Grant undertook the data analysis. The results were published in 2009 (27).

8.3.2 Methods

The design of this study was a patient record audit. The methodology for the larger study is described in 7.2.2 and consisted of recruitment of general practices randomly selected from Auckland and Midland regions. The summary of all the datasets collected is described in Figure 7.3. This project was undertaken in the Auckland region only. Refer Figure 8.2 for summary of the recruitment process for this study.

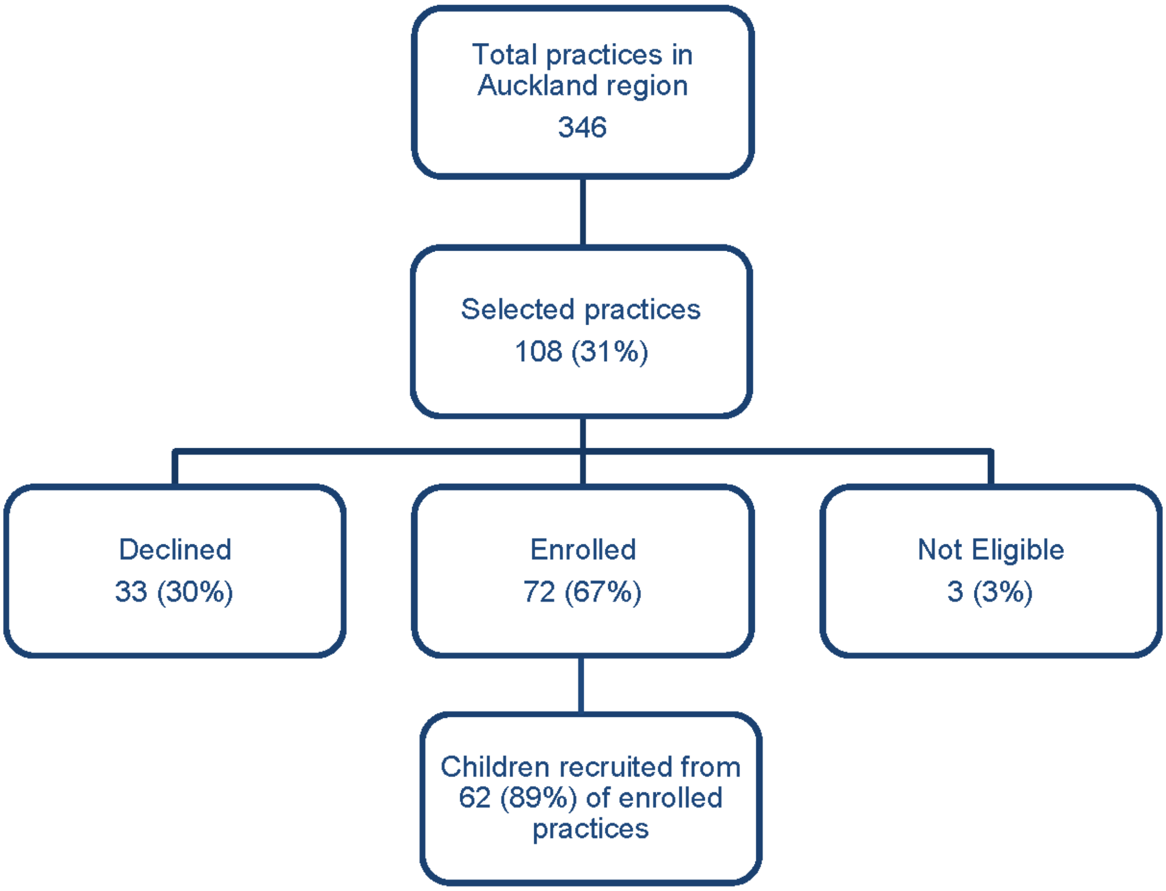
Total practices in Auckland region
346
Selected practices
108 (31%)
Declined
33 (30%)
Enrolled
72 (67%)
Not Eligible
3 (3%)
Children recruited from 62 (89%) of enrolled practices

Figure 8.2: Summary of general practice recruitment for MO study

From each of the recruited practices, ten children aged between 6 weeks and 24 months were randomly selected from the patient database of all eligible children registered. The practice staff obtained written informed consent from their parents for an audit of the child’s health record. The immunisations received by each child were determined by an electronic audit of each PMS as described in 7.2.2. The medical notes of all recruited children were retrospectively audited. All recorded visits were documented. Visits that fell within a date period when an immunisation event was due, but not given, were recorded along with the diagnosis and any contraindication, as understood from the clinical notes. The definition of a true contraindication was based on the NZ standard definition from the NZ Immunisation Handbook 2006 (35). MOs and immunisation completeness for each child were described. Associations of MOs with immunisation completeness were determined using ORs and 95% confidence CIs. Because children were enrolled in groups from each practice, these analyses were adjusted for clustering by practice using SAS-PC version 9.1 and SAS callable SUDAAN version 9.0.1.

8.3.3 Results

Of the 72 practices enrolled, 62 (89%) enrolled consented caregivers for the audit. The other eight practices lacked time or available staff to undertake recruitment. There were 661 children recruited in total and numbers ranged from 8 to 18 per practice. Of these, 655 had complete information. The variance in the number recruited per practice was due to some practices sending out more than ten requests and accepting all.

The audit of the 655 children's records identified 10,094 visits to the practice with a median of 15 visits per child. Of these visits, two thirds (6797) were to the GP, one third (3297) were to the PN with 1614 (6%) having joint visits to both GP and PN. Overall, 556 (6%) of all visits resulted in an MO and MOs occurred at 60 (97%) of the practices. Of the 2002 children who had MOs, 40 (20%) occurred when the first immunisation event was due, 28 (14%) when the second, 55 (27%) when the third and 80 (40%) when the fourth immunisation event was due.

Overall, 447 (80%) of MOs occurred with acute care visits: respiratory tract illnesses in 166 (37%); acute otitis media in 54 (9%); non-specific viral illnesses in 31 (5%); skin infections in 30 (5%); gastroenteritis in 28 (5%); and eczema in 20 (4%). Combined, these six conditions accounted for 65% of all the acute visits where MOs occurred.

There was a significantly smaller proportion of MOs per overall PN visits than for GP visits: Fifty out of 3,297 nurse visits (1.5%) resulted in MOs, compared with 399 (6%) of GP visits (χ^2 = 176, p=<0.001). MOs were more common for the PN, with Well Child visits resulting in 35 (70%) of MOs compared to only 18 (5%) for GP visits; whereas 365 (91%) of the GP MOs were related to acute illness or injury presentations (χ^2 = 183, p<0.001).

True contraindications were present at 5% (28) of visits occurring within the time window of a MO, with possible contraindications in a further 4% of visits. Most true contraindications (89%, 25 cases) were due to acute fever present (temperature >38^{0}C).

Children who had any recorded MO visit were 3.1 times more likely to be incompletely immunised than children with no recorded MO (95% CI 1.87 – 5.14). Children, for whom more than 20% of visits were MOs, had a 9 times (95% CI 4.35 – 19.38) increased risk of being incompletely immunised compared with children who had no recorded MO visits.

Table 8.4: Associations of MOs with immunisation completeness and timeliness

Age Group	Children with any MO visit recorded	Children with no recorded MO visit	Odds ratio (95% CI) of a child with any MO having incomplete immunization compared to a child with no MO*
	Incomplete immunization* n(total n) %	Incomplete immunization* n (total n) %	
3 months to < 5 months	4 (10)40%	5 (37) 13.5%	4.27 (0.52-35.25)
5 months to < 15 months	5 (41) 12%	10 (171) 6%	2.24 (0.72-6.96)
15 months to 2 years	36 (93) 39%	24 (115) 21%	2.46 (1.39-4.36)
All age groups combined	46 (153) 30%	40 (328) 12%	3.1 (1.87-5.14)

8.3.4 Discussion and recommendations

This study showed that MOs occur in almost all general practices, for nearly one third of all children on visits to the practice, and are strongly associated with incomplete immunisation. This was consistent with the international literature, although with MOs occurring in 6% of visits, this was lower than described in US studies (216), where most of the other high income country literature on this topic is from. MOs are more common with acute illness visits. This seems likely to be due to the fact that with an acute illness visit the main focus will be on the presenting complaint and parents and or HCPs may not wish to immunise an acutely unwell child, regardless of the lack of a true contraindication. However, we did note that there are also many follow-up visits that are missing opportunities to immunise. The different pattern from GP to PN is likely to reflect the different nature of the visits, with GPs dealing with more acute issues that are likely to be more difficult overall to focus on, and follow through on immunisation events, than for Well Child visits where preventive health is the primary focus.

Supporting the research with my own experience as an NZ GP, I suggested that barriers to MOs may be related more to issues at the encounter rather than poor provider knowledge, such as the priority of the acute presentation taking precedence and the concerns over lack of certainty about how the acute illness will evolve. Furthermore, the other important barrier is likely to be practice system issues; in particular failure in systems to raise the attention of all staff at all encounters to the overdue immunisation. I recommended the importance of three major areas:

1. Firstly, HCP education, particularly around false contraindications and the ability to confidently immunise a mildly unwell child.
2. Secondly, organisational issues in the general practice; using the PMS efficiently to flag for all members of the practice team, at all encounters, that a child is due or overdue an immunisation event.
3. Thirdly, using a good systematic approach and good teamwork at each encounter.

Finally, I highlighted that the NZ language at the time of an under-immunised child being ‘hard to reach’ was not appropriate. Children overdue immunisation events were frequently attending general practices and there are opportunities to immunise these children with good systematic approaches and greater provider focus and confidence.

8.4 The cost of immunising at the General Practice level

8.4.1 Background

A NZ analysis in 1998 had established that the cost of delivering the childhood immunisations in general practice was not fully covered by the IBS (179). Our 2002 research had identified that GPs considered insufficient funding a barrier to improving immunisation coverage (12). Since that time, the IBS has been increased from NZ$11 (GST inclusive) to NZ$18 (GST inclusive) per immunisation event. Other practice subsidies also contribute small amounts towards the cost of delivering immunisations, in particular the PN subsidy and PHO incentives. However, it was unknown if the new subsidy was adequate reimbursement to cover the costs of immunising the childhood population of a practice, particularly the extra costs required to increase immunisation coverage to national targets, which would require additional efforts, particularly in recalling and tracking children who did not attend with simple precall/recall approaches.

In 2007, we obtained funding from the national organisation *DHB New Zealand* (DHBNZ) to research this topic further. I was fortunate to engage Associate Professor Paul Rouse from the Department of Accounting and Finance in the University of Auckland, who has expertise in health performance and costing systems, to work alongside me in designing this project. Stacey Airey was employed as the project manager, and Helen Petousis-Harris supported the planning and manuscript development.

The aims of this study were to:

- Determine the net average cost to a general practice of carrying out childhood immunisations for the national immunisation schedule for their registered children.
- Develop a cost model following an activity-based costing approach.
- Evaluate the time commitment at the practice required to deliver the schedule childhood vaccines.
- Compare whether costs vary with different practice settings in terms of geographic, ethnic, and socioeconomic factors.

This study was published in 2010 (30).

8.4.2 Methods

We used a pragmatic purposeful selection of general practices nationally, chosen for diversity in size, socioeconomic mix, geography, and practice management style. Data to match the practice socioeconomic mix was undertaken using the NZ Deprivation scale obtained from Statistics NZ website based on 2006 census meshblocks and matched to the corresponding practices' addresses. We selected and recruited practices using the databases and local knowledge of the IMAC staff and networks. Invitations to participate were issued via the IMAC national immunisation networks and the GP electronic news, ePulse.

Data collection tools were developed with feedback from key stakeholder groups, including GPs, practice managers and PNs. They were initially pretested in three practices. These consisted of:

- A financial and total practice time questionnaire, which included major practice overheads and those specifically relating to immunisation, together with the total hours worked by all practice staff.
- An estimate of GP total immunisation time involvement over an average week.
- A 5-day log of time per activity, completed by all staff involved in any of the tasks related to immunisation service delivery.
- A questionnaire covering the less common and monthly events completed by all staff involved in immunisation tasks.

Practices were contacted and followed by a research nurse. Every staff member involved in regular immunisation tasks completed the daily log.

Based on the understanding of the activities involved in the process, a cost model was developed in which the main immunisation-related activities were identified and traced to immunisation events via measurements of both resources and activities. These were classified into a four level hierarchy Refer Figure 8.3. These four levels consisted of:

I. Unit level (immunisation delivery): These are the activities, such as registration check and vaccine preparation, that vary directly with the service of delivery. Unit level costs comprise the cost of these activities, plus the cost of consumables specific to immunisations such as needles, syringes, plasters, and distractions. These costs vary directly with the number of vaccinations delivered.

II. Batch level (managing the service): These are activities required to provide the service, do not vary directly with the number of vaccines given, but are more time related, e.g. ordering vaccines, claiming, and audit procedures.

III. Product sustaining level (resource capability): These are activities associated with providing the service, not directly affected by the batch or unit levels, e.g. cold chain accreditation and staff training costs.

IV. Facility level: This consists of practice level costs/activities that are required to meet infrastructure and/or organisational requirements to facilitate immunisation provisions, but are not directly traceable to immunisation activities *per se* e.g. rent, utilities, insurance, depreciation, financing costs, marketing, operational expenses, waste removal, and support staff.

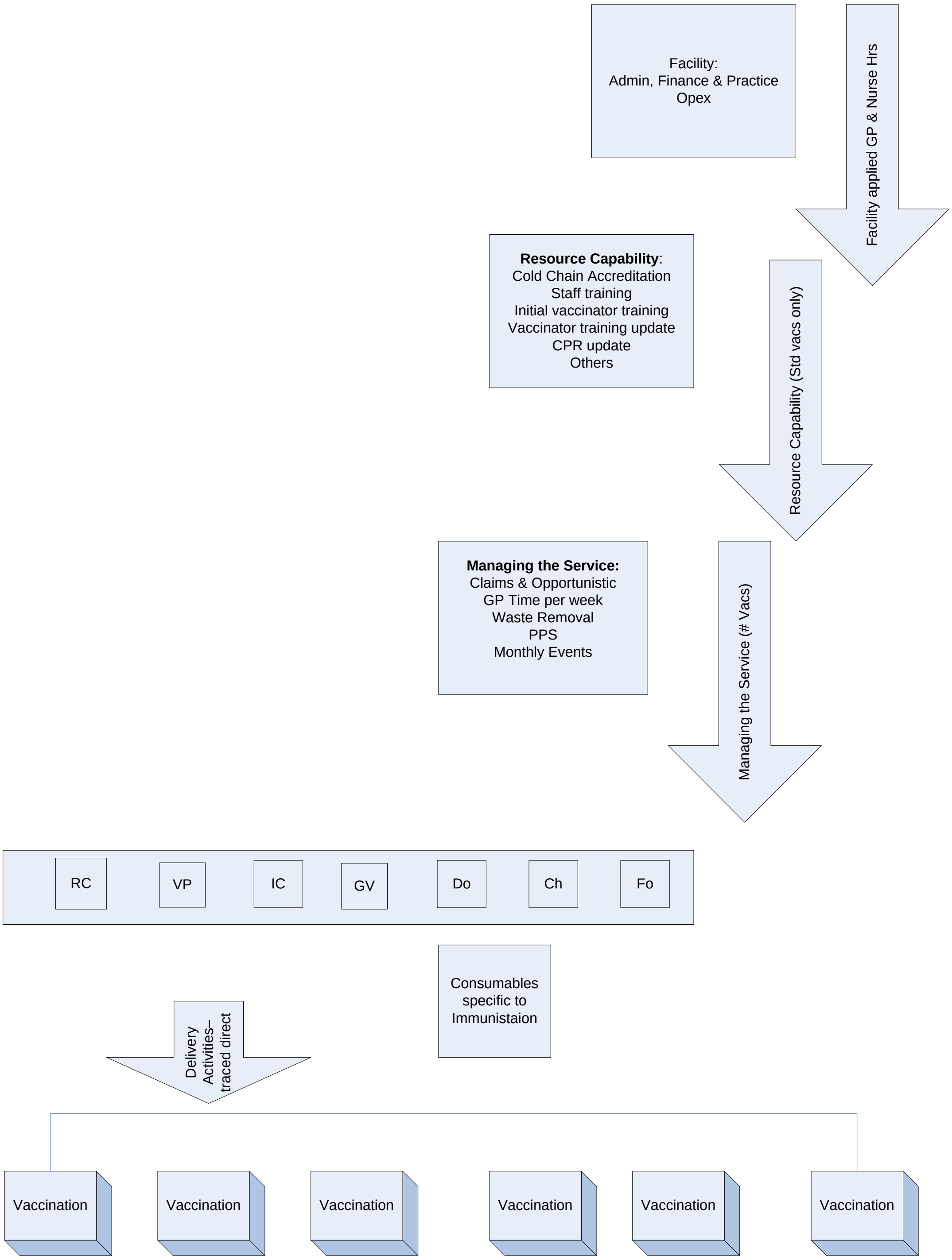

Figure 8.3: The cost model hierarchy

Costs were reported for each hierarchy level. Key assumptions used in the development of the model included: fistly the number of working days per annum was set at 229 (45.8 weeks); secondly the log represented a typical week of immunisation in each practice;thirdly practices have provided their major overhead expenses; and finally GP hours were weighted three times those of nurses to reflect pay differentials in calculating overhead recovery rates. Results for the MeNZB™ vaccine being delivered at the time were separated out from the standard immunisation schedule vaccination. Because this was a special event vaccination, it was not considered part of the routine programme.

A model of a ‘typical practice’ was developed where the best estimates at each hierarchy level were used to estimate the costings at each activity level. The model could then be used to vary volume levels based on different scenarios, to see the overall impact on the total cost and its activity level components. It also provided some reference standards for individual activities within the cost hierarchy. These were derived mainly from the median costs of sample practices, but some were estimated based on knowledge of practice procedures, e.g. the costs of claims were estimated in this model assuming an average time of one minute per claim.

8.4.3 Results

Seventy practices were approached over the data collection phase of December 2007 to May 2008. Twenty eight consented (40%), with 24 (34%) fully completing all the data collection. All practices provided information at the unit and batch levels with no information for four practices at the product sustaining level. The demographics of the practices are listed in the published paper (30) and consist of a spread of sizes, locations, owner operated versus salaries and a wide range of ethnicity breakdown in enrolled populations. Half of the practices surveyed were either unwilling or unable to supply summarised annual overhead costs. The reasons for not participating or failing to complete included staff shortages, confidentiality concerns with supplying information in the financial questionnaire, and the practice staff being too busy to complete questionnaires.

At the facility level, overhead recovery rates were determined for those that did supply this information by dividing total overhead expenses by total estimated GP and PN annual hours. Median overhead recovery rates were $13.5 per PN hour and $40.4 per GP hour.

Across the sample, the mean number of immunisation events delivered over a twelve month period per practice was 926, with a minimum of 65 and maximum of 4949.

1. Time spent on activities directly associated with the immunisation process (unit level)

These activities were captured using the daily log and summarised in Figure 8.4. There was a wide range across all activities between practices in where the time was spent. Overall the most time was spent on the informed consent process, with a mean time of 4.5 minutes and a range for all practices from 1 to 7.7 minutes. There was wide variability across practices (from 1.1 to 8.9 minutes) on the length of time it took to undertake the registration check. There were wide differences in time taken for schedule vaccines, particularly for preparation, delivery, and documentations versus the delivery of the epidemic MeNZB™ vaccine.

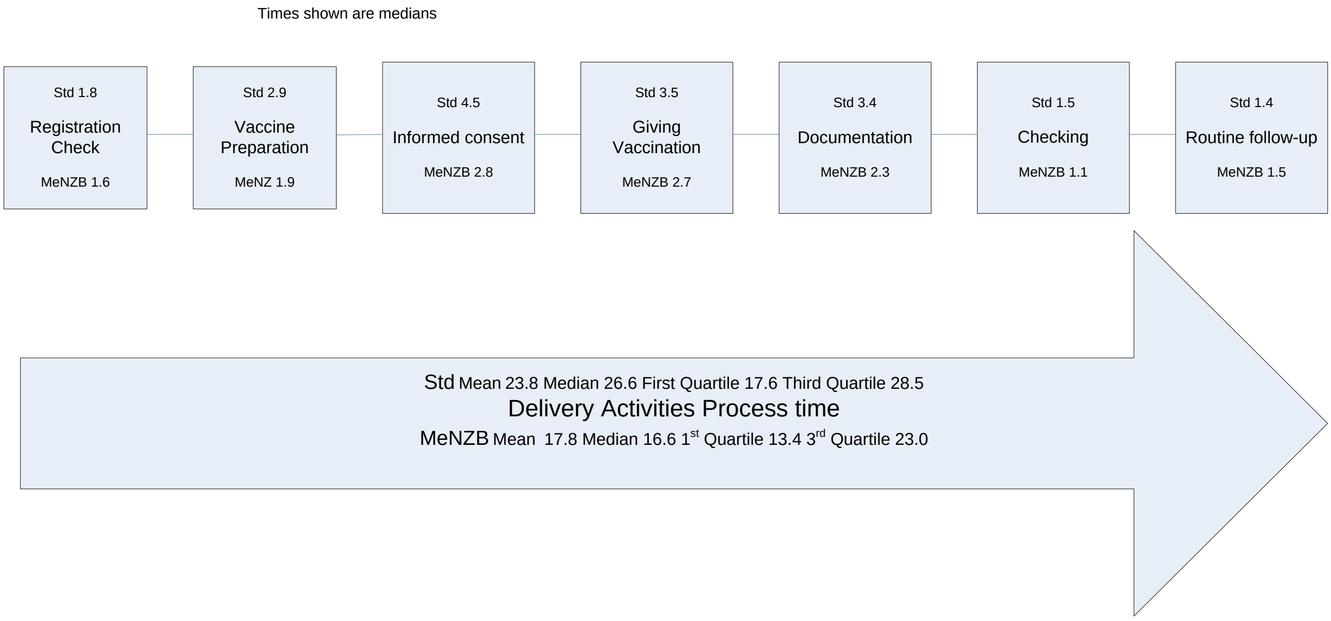

Figure 8.4: Immunisation sequence for delivery activities unit level

2. Time spent dealing with opportunistic immunisation

This was measured in the daily log. Only 14 practices recorded any time at all spent on this activity. The mean time recorded was 30 minutes per month overall (ranging from 12 to 58 minutes over the 25 to 75 percent interval). This represented just over 2% of the total time recorded in the daily logs.

3. Time spent on delivery activities by all personnel

Table 8.5 shows a breakdown of the activities by staff roles. Overall, the PN role used nearly 91% of the total time involved in immunisation delivery, the receptionist around 8% and the GP around 1% of the time. Around 15% of the total work time of a PN (range of 8 to 22%) and a GP around 0.5% (range 0.2 to 0.5%) was spent on standard immunisation activities.

Table 8.5: Total time in minutes (% overall) by activity and staff role across all sample practices for schedule immunisations

(Total time from weekly logs)	Admin	GP	Manager	Nurse	Receptionist	Total
Registration check	3.0 (0.2%)	53.0 (3.0%)	8.0 (0.5%)	1301 (74.5%)	380.5 (21.8%)	1745.5 (100%)
Vaccine preparation				812 (97.9%)	17 (2.1%)	829 (100%)
Informed consent		10 (0.9%)		1146 (99.1%)		1156 (100%)
Giving Vaccinations				1024 (100%)		1024 (100%)
Documentation		6.5 (0.6%)	1.0 (0.1%)	1004 (85.5%)	162.5 (13.8%)	1174 (100%)

(Total time from weekly logs)	Admin	GP	Manager	Nurse	Receptionist	Total
Checking				671 (100%)		671 (100%)
Routine follow-up				307 (100%)		307 (100%)
Total	3.0 (0.0%)	69.5 (1.0%)	9.0 (0.1%)	6265 (90.7%)	560 (8.1%)	6906.5 (100%)

4. Managing the service activities and cost model

Nineteen practices disclosed the hourly rates paid to staff members and there was good consistency of results, particularly for PNs, as measured by the coefficient of variation (CV). Table 8.6 summarises the time spent each month for managing service activities, such as vaccine ordering and dealing with late immunisations. The greatest time commitment was in chasing up late immunisations (average time of 325 minutes a month) and making appointments (average of 206.4 minutes a month).

Table 8.6: Time in minutes spent each month on managing the service activities

	Vacc ordering	Audit	Gen appoints	Gen PP rems	Late Imms	PMS	Org ORS	Adverse events	Total Monthly Minutes
Standard vaccinations									
Mean average time in minutes per month:									
Overall	41.9	13.4	96.8	34.0	149.8	76.1	17.9	12.3	311.0
Nurse	47.4	14.0	109.6	38.7	175.2	74.9	20.0	17.5	425.5
Recep	3.8	15.0	7.5	3.0	0.0	240.0	0.0	0.0	68.0
Median average time in minutes per month:									
Overall	22.5	7.5	60.0	15.0	31.0	31.5	15.0	7.5	181.8
Nurse	25.0	7.5	90.0	30.0	60.0	45.0	15.0	13.1	284.5
Recep	4.0	15.0	1.5	3.0	0.0	240.0			5.8
Number of responses to these questions:									
Overall	27	20	24	15	27	24	17	15	34
Nurse	23	17	21	13	23	21	15	10	24
Recep	3	1	3	1	1	1	1	1	4
MENZb Vaccinations									
Mean average time in minutes:									
Overall	26.1	12.7	104.7	29.4	99.7	50.2	13.4	16.9	228.8
Nurse	29.1	13.5	109.6	33.4	117.1	51.1	15.2	23.8	314.9
Recep	2.8	15.0	1.0	3.0	0.0	120.0	0.0	0.0	36.9
Median average time in minutes per month:									
Overall	15.0	7.5	75.0	9.8	33.8	45.0	15.0	15.0	147.5
Nurse	22.5	7.5	90.0	15.0	45.0	45.0	15.0	15.0	244.0
Recep	1.0	15.0	1.0	3.0	0.0	120.0	0.0	0.0	4.3

	Vacc ordering	Audit	Gen appoints	Gen PP rems	Late Imms	PMS	Org ORS	Adverse events	Total Monthly Minutes
Number of responses to these questions:									
Overall	26	19	22	15	26	23	15	10	34
Nurse	22	16	21	13	22	20	13	7	24
Recep	3	1	1	1	1	1	1	1	4

Table 8.7 summarises the cost at each level across the practices. Overall, the estimated cost for a national schedule-delivered immunisation event was $25.89 with a wide range from $14.38 to $32.50.

Table 8.7: Summmarised data of the general practice cost profiles for national schedule immunisation delivery

	Mean	Median	1st Quartile	3rd Quartile	CV	Typical
Annual # of Vaccinations	**1166**	**926**	**497**	**1544**	0.9	1000
Primary activities cost	$11.41	$12.03	$7.91	$14.12	0.4	$2.03
Consumables	$1.34	$ 0.60	$ 0.28	$0.84	1.4	$0.60
Unit level costs	**$12.03**	**$12.66**	**$ 7.91**	**$15.38**	***0.4***	***$ 12.63***
Claim & support cost	04.56	$283.81	$159.05	$574.25	1.0	$ 694.98
GP time	$2,532.06	$1,847.27	$604.56	$4,408.25	0.9	$1,427.43
Removal	$122.02	$84.60	$70.00	$150.00	0.6	$ 84.60
PPS	$753.49	$721.48	$400.00	$1,095.00	0.7	$1,800.00
Other monthly (annualised)	$ 2,629.60	$1,960.20	$1,066.48	$ 3,545.40	0.7	$1,960.20
Batch level (annual cost)	***$2,859.41***	***$ 2,237.41***	***$1,576.16***	***$3,904.97***	***0.8***	***$5,967.21***
Cold Chain Accreditation	$ 42.41	$ 27.87	$15.11	$57.20	1.1	$28.60
Staff training	$395.97	$164.20	$74.25	$542.91	1.4	$164.20
Initial vaccinator training	$125.99	$137.07	$114.03	$151.80	0.4	$152.53
Vaccinator training update	$83.29	$57.20	$28.60	$87.66	1.1	$ 57.20
CPR update	$126.61	$63.61	$32.63	$170.78	1.1	$63.61
Others	$26.35	$26.35	$19.37	$33.33		$26.35
Product sustaining level	***$563.61***	***$382.37***	***$251.58***	***$711.59***	***1.0***	***$492.50***

	Mean	Median	1st Quartile	3rd Quartile	CV	Typical
Overhead – nurse hrs	$6173.54	$5915.61	$2133.82	$9324.99	0.7	$5915.61
Overhead – GP hrs	$794.04	$ 659.26	$272.26	$1,312.68	0.8	$659.26
Facility level	***$6,729.37***	***$6,972.66***	***$2,172.22***	***$9,495.87***	***0.7***	***$6,574.87***
Total costs for # of vaccinations						
Unit level	$14,435.91	$12,825.66	$4,413.78	$20,070.60	0.9	$12,632.93
Batch level	$2,859.41	$2,237.41	$1,576.16	$3,904.97	0.8	$ 5,967.21
Product sustaining level	$563.61	$382.37	$251.58	$711.59	1.0	$ 492.50
Facility level	$6,729.37	$6,972.66	$2,172.22	$ 9,495.87	0.7	$6,574.87
	$17,858.93	$15,445.44	$6,241.53	$24,687.16	1.0	$25,667.50
Cost per vaccination	*$24.19*	*$23.15*	*$15.38*	*$28.80*	*0.5*	*$25.67*
Unit level	$12.03	$12.66	$7.91	$15.38	0.4	$12.63
Batch level	$3.67	$2.89	$1.48	$5.42	0.7	$5.97
Product sustaining level	$2.08	$0.42	$0.18	$1.78	2.4	$ 0.49
Facility level	$ 8.11	$8.52	$4.81	$9.92	0.6	$6.57
Estimated Vaccination Cost	***$25.89***	***$24.50***	***$14.38***	***$32.50***		***$25.67***

5. Analysis of difference in types of practices

Ordinary least squares regression was used to regress vaccination costs at the unit and batch levels against the practice variables of size, deprivation index, different ethnic proportions and urban rural size. No statistically significant relationships were found. However, when the data were aggregated, time spent on delivery activities increased as the practice size increased. Small practices (>3000 patients) spent a mean of 21.9 minutes on immunisation event delivery, medium sized practices (>3000 to <5000 patients) a mean of 22.5 minutes and a unit cost of $11.48, and large practices (>5000 patients) a mean of 26.9 minutes and a unit cost of $12.80 per immunisation event delivery. Managing the service costs also increased with larger-sized practices, with the main difference being between small practices to medium and large practices; mean costs for small practices were $1,953 per annum, medium sized practices $3,806 per annum, and large practices $3,088 per annum.

8.4.4 Conclusions

The mean time spent on an immunisation activity was 23.8 minutes, with 91% of all staff time provided by PNs. GPs contributed overall around 1% of the total staff time. PNs spent 15% of their total work time on immunisation activity.

We developed a ‘Typical Model’ to better understand costs at the different levels. Using the data from the survey and our assumptions, this model estimated the cost of a standard vaccination at around $25.70 per immunisation event; however, there was considerable variability across practices. While the delivery activity mean was $12, there was a significant range.

This study had some limitations; particularly that it was a purposeful selection of practices. Hence it cannot be assumed to be representative, the sample was small, and there was a wide range in results. Thus, we reported that these results needed to be seen as more indicative than definitive findings.

8.4.5 Discussion and recommendations

There were three particularly important findings from this study:

I. This study particularly highlights the important function of PNs, as the staff with the most involvement in immunisation service delivery in the general practice. PNs spend up to 15% of their total work time involved in the process of delivery of immunisations. The pivotal role of the PN role and time commitment to the immunisation programme needs to be recognised.

II. The level of the IBS was significantly lower than the overall estimates of the cost of delivering a standard immunisation event, and this may be a significant barrier to increasing focus and effort on immunisation service delivery at the practice level, particularly for the children who require extra effort in recall and follow up.

III. There is considerable variability across practices in efficiencies and opportunities for improvement in resource utilisation associated with immunisation services.

It appeared that larger practices spend greater time in immunisation delivery activities, particularly registration checks, documentation and follow-up. It is unclear why this may be the case, but this result needs to be treated with caution, recognising the small sample size.

Time spent on opportunistic immunisation was only 2% of the total recorded time. It was unclear whether this was a limitation of the data collection or whether general practice is spending little time on opportunistic efforts to improve immunisation collection. We felt that this was an area requiring further investigation.

Dealing with late immunisation events appeared, at times, to take a disproportionately large amount of time, as shown by the large range (mean 149.8, median 31 and skewed distribution). This shows that an individual case may take up a considerable amount of practice time affecting the staff workload.

When looking at the ‘typical model’ the greatest variability in cost was the estimate of the GP time commitment to immunisation. If we change the GP time commitment from 20 to 60 minutes a week this would shift the cost to almost $30 an immunisation event. We proposed that a higher amount of GP engagement in immunisation would be useful to support the immunisation process at the practice level, and hence we recommended that higher levels of costings were more appropriate.

8.5 Measuring immunisation coverage at the practice level

8.5.1 Background

One important challenge was to know whether NZ measurements of low immunisation coverage were genuinely due to children not being immunised or whether a component is due to inaccurate data. Data inaccuracies can occur at any level. Prior to the instigation of the NIR, immunisation coverage measurements were reliant on general practice immunisation benefit claims which had significant challenges and the reliability was unknown Refer 2.3.3.

By 2004, at least 99% of NZ general practices used a computerised PMS that had the ability to collect and audit the immunisations given at the practice level (26). A performance management programme was introduced into primary care in 2002, which offered additional funding for practices via the PHOs for meeting certain targets (218). Childhood immunisation was one of the targets, listed as *children fully vaccinated by their 2nd birthday.* All registered patients in a general practice and enrolled with a PHO were to be included in this count. This created a greater incentive for practices to electronically record their immunisation records effectively.

Recognising this background in 2004 (which was prior to the instigation of the NIR), we developed a study to determine whether the improvements in the electronic recording of immunisation events on the PMS following the instigation of the performance management programme had improved immunisation coverage reporting (26). The study aimed to investigate the quality of data-recording by the practices and identify issues of concern that could be addressed to improve measurement. This study was designed and led by Felicity Goodyear-Smith and used the data from the larger study on the determinants of immunisation coverage. It was published in 2008 (26).

8.5.2 Methods

Data collection is outlined in 7.3.2 and was undertaken from 2005 to 2006. The random sample of 124 practices, 70 from the Auckland region and 54 from Midland was used for an audit of the coverage data. In order to identify all the children on a practice database, regardless of their immunisation status, two queries were built to be used with the major PMS systems. The first query generated the list of all children aged between 6 weeks and two years who had visited the practice, regardless of their registration status. The second query generated the dates and types of all the immunisations given. Data were extracted in an anonymised format when the research assistant visited the practice and results from both queries were merged.

8.5.3 Results

The 124 practices selected from the larger study described in 7.3.2 were all used for this study. There were five different electronic PMS systems used and one paper-based system. Refer Table 8.8. Our research assistant visited all enrolled practices and collected the data, undertaking 134 visits overall. He reported that the practice staff rarely understood their practice systems and did not usually demonstrate full technical competence. They also saw the payment required by the vendors support as a possible barrier to up-skilling. The one paper-based practice required a labour-intensive process of identifying all children in the age range from the age/sex register and reviewing all the records.

Table 8.8: PMS used by general practices in the study

PMS	Auckland n (%)	Midlands n (%)	Total n (%)
Medtech-32	53(76)	42 (78)	95 (77)
GPData/next generation	9 (13)	2 (4)	11 (9)
Profile for windows	2 (3)	6 (11)	8 (6)
Houston	0 (0)	3 (5)	3 (2)
Own system	0 (0)	1 (2)	1 (1)
Paper practice	1 (1)	0 (0)	1 (1)
Total	**70 (100)**	**54 (100)**	**124 (100)**

8.5.3.1 Patient status

There were two sets of variables. The first recorded whether the patient was enrolled or not enrolled, and while this was undertaken at the practice it applies to the PHO enrolment. The second set included a variety of options, including ‘registered’, ‘casual’, ‘visitor’, ‘transferred’, or ‘died’. Only 57% of children registered with the practice were enrolled with the PHO. This complexity was not able to be captured by the standard PMS audit reports. To capture all the target children at the practice the query had to include ‘registered/not registered’, ‘enrolled/non enrolled’, and ‘casual/not casual’. There was very large variation in the proportion of children enrolled with the PHO, from almost none to the majority being enrolled.

Different PMS have different fields in which to enter immunisation data. Most have a drop-down pre-determined list and an extra free text box. The free text box meant that entries could all be captured as different vaccines for example ‘hepB’, ‘HepB’, or ‘Hepatitis B’. There was a lack of consistency as to where data were entered.

8.5.3.2 Dates

In some records, the date for the receipt of the vaccine event was the same for all dates, e.g. 6 weeks, 3 months and 5 months events were recorded as being given on the same day. This was the date of entry, not the date of delivery, and it was usually created by a child transferring from another practice and the data being entered, but the actual dates when given not entered. There was also uncertainty about where the original record of the dates had been sourced from i.e. whether it was based on a parent/caregiver verbal report or derived from a previous practice record. There were some episodes where a specific vaccine was entered, but it was not clarified whether it was declined or given. The distinction could, at times, be determined from another coded field or free text field. In the NextGeneration and Medtech systems, if the information had been entered it was clearer to see if a vaccine event had been declined. However, in NextGeneration the decline date could be the same for all vaccine events.

Other identified errors included earlier dates listed for later immunisation events, and dates that clearly did not match e.g. for an MMR vaccine received during the first 6 months of life.

An immunisation event was only counted if the date was listed in the data field for each event. The percentage of all children for whom immunisation events were recorded as given was approximately 70% for the 6 week event, 60% for the 3 month, 55% for the 5 month, and 20% for the 15 month event. There was a wide variability across the practices in the proportion of children for whom this data was recorded and the variability was greater for the younger events than the 15 month event.

The major types of data error were:

I. Immunisation events listed as given at the same date in a media of 10% of practices.
II. Earlier immunisation events listed as given after later immunisation events in a media of 3% of practices.
III. Subsequent immunisation events listed, but not earlier events in a media of 4% of practices.
IV. Establishing whether immunisation events had been given.

Medtech has a number of outcome fields for each vaccine. Refer Table 8.9

Table 8.9: Medtech 32 vaccine outcome codes

Outcome Code	Code Interpretation
AG	Alternative given
CIS	Closed not required
CPI	Closed by provider
D	Declined
DEC	Declined elsewhere
DIC	Declined by individual
DMC	Medical contraindication
DNI	Natural immunity
DPC	Declined by parent
E	Given elsewhere
G	Given
GE	Given elsewhere in NZ
GO	Gone overseas
N	Not given
NR	Non-responder
R	Refused
RE	Rescheduled

These were used in different ways by different practices and there was not a clear standard approach to using them. The other PMS systems did not have the same codes. In particular, if a parent/caregiver declined a vaccine for their child, the information was sometimes entered in a ‘notes’ field but other times in the free text body of the clinical notes of the child and therefore not coded.

Children who had received an earlier vaccine event elsewhere needed to be entered to enable generating the recall for the next event. Where immunisations had been declined, a practice would sometimes remove the child from the recall list and this changed either the denominator or the numerator, depending on how the numbers were derived from the PMS.

Children called ‘non-responder’ (i.e. those who had not responded to recall), were managed differently between practices. An example given was one practice sent out three recall letters then removed the child from the system if there was no response. Another practice followed up with phone calls and possible outreach services. Some children, removed from the recall system still had the ‘flag alert’ function present on their record, to identify them for possible opportunistic immunisation when presenting to the practice for other purposes.

There was a few children identified who had been immunised and recorded in the clinical records parts of the notes, but not picked up by the PMS query.

8.5.3.3 Date of recall

Approaches to recall were not consistent between practices. Recalls varied, with some doing none at all and any time up to three monthly. There were no consistent recall protocols. Recalls could include those due, nearly due, or overdue or a mixture of all three. The PMS recall function could get modified by providers and from observation many practices were using the function, partly on the PMS and partly on their own personalised system, for tracking overdue children. Some practices also used PHO data that did not always match with their own PMS data, or they would alter the recommended overdue date on their own PMS system away from the recommended MoH default overdue dates.

8.5.3.4 Unique identifiers

The National Health Index (NHI) is the NZ unique identifier number. However, not all patients in a practice had the NHI entered. Medtech 32 generates its own unique number, which is at times used as an alternative identifier. Using incomplete and multiple unique identifiers increase the potential for a child to be duplicated on a practice patient list or across practices.

8.5.3.5 Error analysis

Following running the queries, there was considerable error analysis and data cleaning required. Because there was considerable variability of codes for specific vaccine events, interpretation was needed to decide which vaccine was actually given. There was a range from some practices having no immunisation events categorised as ‘other’, which then needed to be individually determined, to some practices having large amounts of ‘other’. We reported a practice that required considerable review by our research assistant to complete the study, with 269/2815 (9.5%) of all recorded immunisation events being in the ‘other’ category. Medtech 32 can determine whether a date beside an immunisation event meant that it had been given, given elsewhere or declined by checking the outcome codes. This feature is in the NextGeneration system, but seldom used, and is not possible in the other systems.

8.5.3.6 Summary of immunisation coverage

For registered and enrolled children, a media of 68 to 75% of children in each practice had received their due immunisation events according to their age and the immunisation schedule. A media of 45% were delayed for at least one event. The variance across practices was large.

8.5.4 Discussion and recommendations

What is clear from these findings is that there were many challenges to accessing accurate and standardised immunisation coverage reporting from a PMS system, as they were functioning in the NZ context in the time period of this study 2005 to 2006. The differences between a PHO enrolment and a practice-based registration were the first challenge, creating confusion as to what was the denominator base. Government subsidies were via PHOs and hence apply to enrolment, but practices worked on a registered client base. There were further problems around registration in this time period, as there was a significant problem with what was called ‘clawback’, where the practices had to pay to an after-hours service or an accident and medical clinic when they saw their registered patients. This disincentivised practices to register young children, potentially creating an even bigger gap from PHO enrolment to practice registration.

Data quality issues were multiple and due to a range of factors. Firstly, we identified a well-recognised phenomenon that end-user usage tended to be in a format that suited the user and was not focused on the needs of gathering aggregated data. There was diversity, both in the quality of the data and the expertise in using the data. Some systems were developed for alternative purposes, such as billing purposes, and subsequently modified to try and measure immunisation coverage. Different PMS systems allowed variable types and degrees of errors. There was no data quality-checking processes within the PMS and between the clinic staff entering the data.

It was clear from this study that it is important to have detailed knowledge of systems and processes and an understanding of the drivers for the users. Particularly, it is important to recognise that open fields and multiple choices are likely to create significant complexities when trying to obtain accurate and replicable data. Multiple different PMS providers also create problems with standardisation, data sharing, and the ability to consistently alter and update.

We concluded from this study that there needed to be a focus on data quality, which we suggested should be driven from national directives to create a standardised minimum immunisation dataset and mandating the requirements with the PHO contracts. This needed to include:

I. Early enrolment and registration, preferably at birth.
II. A standard denominator definition that includes all children under the care of a particular practice.
III. A standard definition of a delay in an immunisation event.
IV. More consistency across PMS systems: in particular, the need to standardise the fields that capture immunisation data.

V. Training for staff in use of their PMS.
VI. Use of intrinsic data checks, i.e. making less space for human error and variability as much as possible by using menu-driven and single places for data entry.

Following this study, the NIR was introduced in 2005. The NIR extracts data directly from the PMS and NZ data has been reliant on the PMS/NIR accuracy since that time. Therefore, the effectiveness of the NIR is entirely reliant on effective data entry for the immunisation event at the practice level. While I have not undertaken any further published research in this area, from my service delivery experience in the first few years of the NIR I observed that there were considerable challenges with the PMS to NIR interface. IMAC undertook several audits of the data problems for various DHBs and PHOs and made a range of recommendations similar to those listed above. Much activity has occurred in this arena since, including working with PMS providers to improve the intrinsic data checks and reduce free field data, and intensive focus on provider training at the practice level in the use of PMS.

In the early years of the NIR there was considerable expressed lack of confidence in the system, with large amounts of reported errors. With much time and effort, errors now are more rarely reported in this interface, and the general practice-provider confidence in the PMS/NIR interface is generally very high. The ‘clawback’ issues have been altered to reduce the financial loss to the practice for young children attending elsewhere, and policy has encouraged enrolment to occur as soon as possible after birth.

8.6 Combined analysis of provider, caregiver and systems factors

How important is each component part of the system? We undertook a combined analysis of all the different components of the research study that focused on the determinants of immunisation coverage and timeliness of delivery at the general practice level as described in sections 7.3, 7.4, 7.5 and 8.2. Cameron Grant undertook the analysis.

8.6.1 Results

A multiple regression model of demographics, provider (PN and GP), and caregiver associations with practice immunisation included 76 practices and explained 80% of the total variance in coverage between practices(25). Refer Table 8.10 which is adapted from Grant et al 2011 (25). Coverage decreased as the socioeconomic deprivation of the registered practice population increased (p <0.001), varied by region (p=0.002), and by style of governance of the practice (p<0.001). Coverage decreased as the age of registration of the infant with the practice increased (p <0.001); was higher at practices that did not experience staff shortages (p =0.004), where the doctor was confident in his or her immunisation knowledge (p = 0.005) and where the nurse had dedicated time for immunisation follow-up (p = 0.05); and was lower at practices where caregivers reported receiving discouraging information about immunisation in the antenatal period (p = 0.0008).

Table 8.10: Combined analysis of practice, child, health professional and caregiver associations with practice immunisation coverage

Variable	Direction of effect on coverage	Multivariate p value
Demographics		
Region	Higher in Midlands	0.002
Governance	Higher in non-Māori governance practices	<0.001
Socioeconomic deprivation	Decreases with increasing socioeconomic deprivation	<0.001
Age of registered children	Decreases with increasing age	<0.001
Practice		
Age of children at registration	Decreases with increasing age at registration	<0.001
Staff shortages	Higher in practices with no staff shortages	0.004
PN		
Dedicated time for immunisation follow-up	Higher at practices where the nurse has dedicated time	0.05
GP		
Confident in own knowledge about immunisation	Higher at practices where the GP is confident in his/her knowledge	0.005
Caregiver		
Received discouraging immunisation information antenatally	Lower at practices where the caregivers received discouraging information	0.008

The same multiple regression model of demographic, PN, GP, and caregiver association explained 68% of the variance in immunisation timeliness of delivery between practices. Refer Table 8.11 reproduced from Petousis-Harris et al (24). Timeliness of delivery varied with different styles of practice governance (p=0.05). Delivery of immunisation events was delayed in practices with higher socioeconomic deprivation (p<0.001), delayed with increasing age at registration (p=0.02) and where parents had been given discouraging information antenatally (p =0.004); was improved in practices with less staff shortages (p=0.01); and varied with the attitudes of both PNs (p=0.01) and GPs (p= 0.008).

Table 8.11: Combined analysis of practice, child, HCP and caregiver associations with immunisation timeliness of delivery

Variable	Direction of effect on timeliness	Multivariate p value
Demographics	More timely in non-Māori governance practices	0.05
Governance	Less timely with increasing socioeconomic deprivation	
Socioeconomic deprivation		<0.001
Practice		
Age of children at registration	Less timely with increasing age at registration	0.02
Staff shortages	More timely in practices with no staff shortages	0.01
PN		
Nurse perceived parental apathy as a barrier to immunisation	More timely in practices where the nurse had this perception	0.01
GP		
Doctor perceived parental access difficulties as a barrier	More timely in practices where the doctor has this perception	0.008
Caregiver		
Received discouraging immunisation information antenatally	Less timely at practices where the caregivers received discouraging information	0.004

8.6.2 Conclusions

The significant factors that need to be considered for effective solutions from this combined analysis recognise a range of socioeconomic, parental, staff, and practice factors that include the SES of the enrolled population, information given to parents antenatally, the style of governance of a practice, early registration and engagement with a practice, stability of staff and less staff turnover, enough time for staff to focus on the necessary work of immunisation service communication and delivery, and staff confidence, which would include both education and practice stability factors.

8.7 Summary of Chapter 8

This chapter focused on the important role of the systems and process at the practice level and how they contribute to childhood immunisation coverage. Research is presented around the factors at the practice level that impact on immunisation coverage and timeliness of delivery, which particularly highlights the importance of early enrolment and engagement, PMSs, staffing, resourcing and type of practice. Further research focussed on the factors that contribute to missing opportunities to immunise children when they present at the practice and findings around the costs involved in the immunisation delivery process highlight there is a gap between funding and actual service delivery. How immunisation data is entered at the provider level affects coverage rates is reported. Combining many factors affecting immunisation coverage and timeliness of delivery shows there are important socioeconomic, parental, HCP, and practice characteristics that all contribute to coverage rates.

CHAPTER 9 EFFECTIVE APPROACHES TO IMPROVING IMMUNISATION COVERAGE AND TIMELINESS OF DELIVERY

9.1 Outline of Chapter 9

The previous chapters have outlined the range of barriers that we have identified as affecting immunisation coverage and timeliness of delivery in the NZ setting. These barriers include parental knowledge and attitudes as discussed in Chapter 5, aspects of the family and social environment identified in Chapter 6, issues related to the health providers discussed in Chapter 7, and the structure and delivery of the health services presented in Chapter 8. The aim of this chapter is to present further research focusing on effective strategies to improve immunisation coverage at the service delivery level. In this chapter, I present firstly an intervention study and secondly an observational study that identifies the most effective practices directed at improving immunisation uptake at the general practice level.

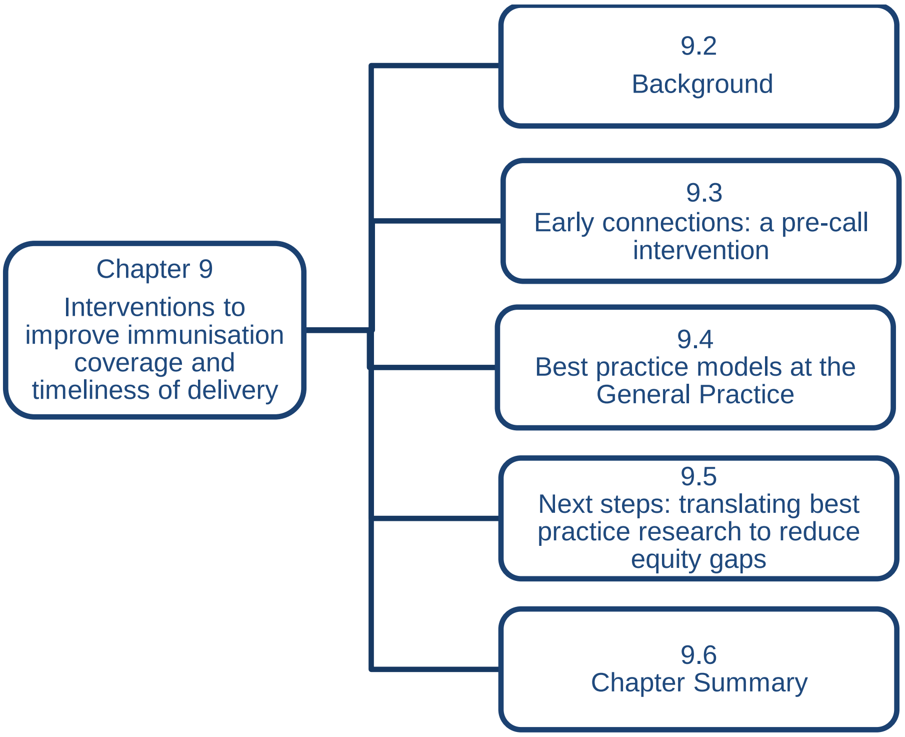
Chapter 9
Interventions to improve immunisation coverage and timeliness of delivery
9.2
Background
9.3
Early connections: a pre-call intervention
9.4
Best practice models at the General Practice
9.5
Next steps: translating best practice research to reduce equity gaps
9.6
Chapter Summary

Figure 9.1: Outline of Chapter 9

9.2 Background

The research I presented in the earlier chapters identified the important factors that affect immunisation coverage and timeliness of delivery. Our research findings were consistent with the international research outlined in Chapter 3. Following the completion of this body of work, we considered we had sufficient information to move towards designing an intervention study, rather than undertaking further descriptive approaches.

The strongest evidence for improving coverage appeared to lie in focusing on improvements in the front line systems for healthcare providers (25), which includes obtaining and maintaining good engagement and effective relationships with parents (19). The international literature particularly identifies the importance of early relationships between providers and the infant's family as being effective in reducing delay for the first immunisation event, which in turn, significantly increases the likelihood of completing the full infant immunisation course (193). There are challenges in the NZ policy environment for enabling primary care early engagement to support building effective relationships between parents and providers. The antenatal period in particular is seen as crucial for parental decision-making, but often parents have little contact with the general practice during this period (19).

Our intervention study took into account both the importance of good family engagement and good practice systems. Using these two areas, we focused on engagement and effective pre-call in the early postnatal period. Because general practice is not reliably engaged in the antenatal period, the early postnatal period is the earliest time they can regularly engage with families and their new infants. This study was published in 2012 and is discussed below in 9.3 (31)

My second study focused on identifying the major factors at the practice level that can either help or hinder immunisation uptake. We recognised that, even when national immunisation coverage rates are generally low, there are general practices that are able to obtain and maintain high immunisation rates (211). Based on this, we focused on delineating the particular characteristics from the high performing practices. We labelled this 'best practice at the practice'. If we could identify these features of 'best practice' then we could use this information to translate this knowledge and experience across to other practice settings. This study has a manuscript in preparation and is discussed in 9.4 (34).

9.3 Effectiveness of a pre-call intervention to improve immunisation coverage and timeliness

9.3.1 Background

The team of Felicity Goodyear-Smith as Principal Investigator, myself, Helen Petousis-Harris and Cameron Grant designed a randomised control trial intervention study to be delivered in the general practice setting, focusing on the early postnatal period. Our hypotheses were that early engagement with the parent would help the timely delivery of the first immunisation event, and that achieving the first immunisation event on time would improve the immunisation timeliness of all the primary course immunisation events. The aim of the study was to assess the effectiveness of a general practice-based pre-call intervention delivered prior to the six-week immunisation event on the timeliness of the primary immunisation course. The study was funded by an HRC grant. We had further advice and statistical help from Rafael Perera and Anthony Harnden from Oxford in the UK, the project manager was Anthea Palmer, and the IMAC research assistant was Tracey Poole, who helped to deliver the intervention.

9.3.2 Methods

This was a clustered RCT comparing general practices that used a multi-component intervention with general practices that delivered the standard care. The study was undertaken from 1 November 2008 to 20 April 2010 and involved recruiting practices in the Auckland DHB catchment area.

9.3.2.1 Intervention

The intervention consisted of a short letter of welcome, brief immunisation information and an invitation to attend the practice when the infant was six weeks of age. This was sent to the caregiver by the practice when the infant was four weeks old. It was followed by a telephone call to the caregiver when the infant was five weeks old, if an appointment had not already been made. A further contact attempt, preferably by telephone, but alternatives included text message, email or letter, was made when the infant was seven weeks old, if they had still not attended for their immunisation event. Recognising the extra time this intervention took to deliver, practices were given a NZ$15 shopping mall voucher, regardless of the outcome for the infant.

9.3.2.2 Recruitment

Practice recruitment was from a list of all 148 general practices in the area, obtained from combined databases from IMAC and the Department of General Practice and Primary Care, University of Auckland and cross-referenced to the telephone directory to ensure there were no missing practices. Practices that were identified as not being involved in delivering infant immunisations were excluded. All the remaining practices were randomised using a computer random number generator to either the intervention or control group. Except for the project manager, the research team was blind to the identity of practices in either group. Recruited intervention practices were assisted to electronically adjust their PMS, to automatically send out re-call and recall letters to all infants in their practices due their first immunisation event.

Outcome information on immunisation events was obtained from the NIR using the infant’s NHI number. The primary measure was receipt of the six-week immunisation and the time of receipt. Secondary measures were receipt of the three and five-month immunisations and the time of receipt. Surveys of participating practices were also conducted pre and post the trial to establish their practice population and their routine immunisation precall / recall practices, both before and after the trial.

9.3.2.3 Data analysis

Each enrolled practice was considered a cluster. The trial was powered based on timely receipt of the three and five-month immunisations. Based on our learnings from our previous research (23), we calculated a sample size of 1000 interventions to be sufficient to have 80% power at the 0.05 level of statistical significance to detect an increase in timeliness of coverage at the three-month event from 75% to 94% and from 60% to 85% at the five-month event. The variables in the dataset consisted of the NHI number, which was converted to a unique identifier, date of birth, dates for each of the three immunisation events at six weeks, three and five months, and nominated practice at birth. Birth immunisation events for BCG and hepatitis B were not included.

The delay in immunisation was measured by a survival curve analysis. For each infant, the days from the due immunisation event date to the actual day they received the vaccines were counted. The second and third dose assumptions were used, which states that if the three and/or five-month immunisation events had been given, the child is assumed to have previously received the earlier doses. Total scores by the number of delayed days were compared using survival analysis with Kaplan-Meier and Cox proportional hazards to test for any significant differences:

1. For the intervention versus the control group using an intention to treat analysis.
2. For those who had precall versus non precall in the intervention group.
3. For those who had precall in the intervention group versus those who had precall in the control group.

This approach allowed analysis by continuous, rather than dichotomous, data and provided greater statistical power. Adjustment was also undertaken for clustering.

9.3.3 Results

There were 148 practices in the region, of which 128 were eligible. Of these 63 were recruited and 65 non-recruited (called the C group). The recruited group were randomised to 31 in the intervention arm (the A group) and 32 in the control arm (the B group). Groups A, B and C were similar with response to the socioeconomic status of the practice locations and the average practice size. In terms of infants born in this period there were slightly more in the control group B than in the intervention group A.

The intervention Group A had 2842 infants enrolled over this period. Only 1198 (42%) of these infants received the pre-call intervention. The reasons for the others not receiving the intervention included practices not receiving or being aware of the birth notification from the NIR in time, and PNs stopping the intervention for some periods -for example over the summer period when there were locum nurses. In many instances, details were not recorded of what the intervention consisted of and how often the five-week and seven-week calls were undertaken. One practice failed to deliver any interventions at all.

The overall immunisation rates for the six-week immunisation event completed by eight weeks of age are show in Table 9.1 which is adapted from Goodfellow-Smith et al (31). The percentage completed for the practices in the study overall was 98%. There were 472 children on the NIR who had no nominated practice and when these were included in the study, the rate dropped to 94%.

Table 9.1: Overall immunisation rate for the six week event for intervention, control, non-participating practices and infants with no nominated practice

Type of practice	Vaccine received by 9 weeks of age	Opted off/declined	No NIR data	Total	% complete by practice type	% completed by A, B or C practice only	% completed for whole population
A	2743	53	46	2842	97	98	94
B	2388	26	0	2414	99		
C	5744	83	0	5827	99		
D1	32	16	0	48	67		
D2	0	0	424	424	0		
	10907	177	470	11555			

Key
A = intervention practice
B = control practice
C – non-participating practice
D1 =infants with no nominated practice, 6 week immunisation data available
D2 = infants with no nominated practice, six week immunisation data not available

The immunisation event consists of two vaccines, the DTaP-IPV-HepB/Hib and the PCV10. Scatter plots of the difference in timing between the two vaccines for all cases, and then for those in practices A and B, showed that these were rarely given separately; therefore separate analyses were not required.

The average age of receipt of the six-week, three-month and five-month events (as measured by receipt of the DTaP-IPV-HepB/Hib vaccine) is shown below in Table 9.2 which is adapted from Goodfellow-Smith et al (31). The non-consenting practices, (Group C) consistently had a slightly longer average delay than recruited practices (A and B), but the children who had no nominated practice had a much greater average delay. Overall, 88% of infants attended the practice their parents nominated at birth and 12% were either vaccinated or declined immunisation at a different practice for the six-week event.

Table 9.2: Average age of receipt of the immunisation DTaP-IPV-HepB/Hib at 6 weeks, 3 months and 5 months by practice type

Practice Type	Average age in weeks of receiving the six week vaccine	Average age in months of receiving the three month vaccine	Average age in months of receiving the five month vaccine
A	7.06	3.40	5.64
B	7.09	3.43	5.65
C	7.26	3.48	5.7
D	8.92	4.49	6.32

Key
A = intervention practice
B = control practice
C = non-participating practice
D = infants with no nominated practice

Data were analysed both by using the second and third dose assumption, and by categorising children into having no information on the six-week event. This made a very slight difference in coverage rates.

Using an intention to treat analysis, there was no statistical difference between the A and B practices (Log Rank (Mantel-Cox): Chi-square 0.268, df=1, p = 0.605). There was no difference in days to immunisation for the three-month vaccine event (Log Rank (Mantel-Cox): Chi-square 0.540, df=1, p = 0.46), nor for the five-month event (Log Rank (Mantel-Cox): Chi-square 0.281, df=1, p = 0.60). This analysis did not take into account the consideration that 58% of infants in the A practices did not receive the intervention.

Conducting a further analysis, we stratified infants in Group A by actual delivery of the intervention. This showed that those receiving the intervention were significantly more likely to receive their six-week immunisation event earlier ((Log Rank (Mantel-Cox): Chi-square 19.187, df=1, p <0.001). The mean days to the six-week event were 49.6 days for those who received the intervention compared with 51.2 days for those who did not. The same analysis was undertaken for the three-month event (Log Rank (Mantel-Cox): Chi-square 16.527 df=1, p < 0.001), with mean days for those with intervention 100.1 compared with 103.8 for those without; and for the five-month event (Log Rank (Mantel-Cox): Chi-square 11.621, df=1, p = 0.001), with mean days for those with intervention 166.2 compared to 170.1 for those without.

A third analysis compared infants in the A (intervention) practices who had received the intervention with all infants in the B (control) practices. There were similar results with significant differences for the six-week event (Log Rank (Mantel-Cox): Chi-square 5.969, df=1, p = 0.015), the three-month event (Log Rank (Mantel-Cox): Chi-square 10.722, df=1, p = 0.001), and the five-month event (Log Rank (Mantel-Cox): Chi-square 6.753, df=1, p = 0.009).

The timeliness analysis was then repeated to include the C group (the nonparticipating practices). C Group practices had significantly higher delayed immunisation rate for the six-week event (Log Rank (Mantel-Cox): Chi-square 14.705, df=1, p = 0.001),

9.3.4 Conclusions

Overall, our study showed that enrolment and early engagement with a general practice appears to improve delivery and timeliness of delivery of the infant immunisation events. Children not enrolled are more likely to miss out or be delayed in the receipt of their immunisation events.

Limitations of the study included recruiting fewer practices than we had intended and delays in some practices implementing the intervention, with only 42% of all the eligible children receiving it. We also had incomplete records on how often the intervention included the five-week pre-call and/or the seven-week recall contact.

9.3.5 Discussion and recommendations

When we designed this study in early 2008, the immunisation rates from NIR data were around 88% for the six-week event, 75% for the three-month and 60% for the five-month event and sample size was calculated based on these figures. However, coverage rates continued to improve over this time and the coverage rates for enrolled infants in all practices in this study were much higher than expected at 98% for the first event with very little drop-off for the next two events. We did show there was a significant improvement in timeliness of immunisation event receipt when using the designed intervention, as compared to not using it. However, because the coverage rates were so high, this only translated into infants receiving the vaccine on average one day earlier, which is not clinically relevant.

Another important other finding was the 474 infants, overall 4% of the cohort, who did not have a nominated practice at birth. For those who had an entry for the six-week event, one third were not vaccinated. This group dropped the overall coverage rate significantly for the whole region from 98% to 94%. This demonstrates that infants with no nominated general practice at birth, are much less likely to get immunised or to be delayed in the receipt of the event.

We discovered a number of errors in routine immunisation data collection that affected this study. Firstly, with the NIR, at times the practitioner (usually the PN) had entered incorrect data in the PMS; there were technical problems with data transfer to the NIR; error messages back from the NIR may not have been acted on, or the practitioner may not know have how to act upon them. Complex ‘catch up schedules’, such as children from different countries or late presentations, can be difficult to enter accurately into the PMS, with transfer data between practices being not fully electronic, and new practices often needing to manually enter previous immunisation events.

Based on these results, we recommended the importance of getting children enrolled with general practices at birth, or as soon as possible after birth, and targeting outreach services for those who continue not to have a nominated general practice.

9.4 Identifying models of “Best Practice at the Practice”

9.4.1 Background

In recognition of the ability of many general practices to achieve and maintain high immunisation coverage we designed a study to utilise the experience of these high performing practices to identify the particular factors at the practice level that either help or hinder immunisation uptake. If we could identify these features of ‘best practice’, we then intended to use this information to translate this knowledge and experience across to other practice settings. We obtained an unrestricted grant from GlaxoSmithKline New Zealand Limited to fund this research. The funders had no involvement in the design, planning or delivery of the project. Dr Lynn Taylor was the Principal Investigator, working with myself and Catherine Poutasi.

The aim of this study was to identify successful strategies to be shared amongst health providers, in an attempt to accelerate the increase in immunisation coverage in NZ. We were also focusing on identifying successful methods that engage with Māori communities to increase immunisation coverage in Māori children which will help reduce health inequalities and narrow the immunisation coverage gap between Māori and other ethnicities. The overall goal was to translate ‘best practice models’ into national guidelines or otherwise make these models available to general practices throughout the country.

9.4.2 Methods

9.4.2.1 Study Design

This study was qualitative, using semi-structured face-to-face interview with one or more key informants from general practices identified as having high immunisation coverage rates. ‘High performing’ practices were identified throughout NZ based on nominations from DHBs, PHOs, Immunisation Advisors/Coordinators and PNs. The nominations were called for through IMAC staff networks of DHBs and PHOs as well as in the IMAC national newsletter. Practices were purposefully chosen based on achieving high immunisation coverage and then selected for geographic, ethnic and socioeconomic diversity. ‘High performing’ was defined as greater than 90% of their eligible population by two years of age, The key informant was the practice staff member identified as having the responsibility for the immunisation delivery in that practice as nominated by the practice. In all cases this was either a Practice Manager or PN. Interviews were face-to-face, of approximately two hours duration, and conducted at the practice.

The themes to be explored in the interviews were given to the participant practice teams prior to interviews, along with a pre-visit questionnaire to collate quantitative data on practice demographics. The interview guide covered ten areas that had been identified by the immunisation coodinators working for IMAC as the major components of immunisation service delivery within a general practice:

1. Staff resourcing and prioritisation of immunisation within the practice.
2. Connection and communication with child’s care giver/s.
3. Internal practice systems and processes for ongoing communication.
4. Connection with difficult to find children.
5. Practice use of NIR.
6. Use of PMS and any other IT support tools.

7. Practice immunisation targets and performance monitoring.
8. Practice staff training and continuing education.
9. Patient and community education.
10. Practice staff turnover.

9.4.2.2 Data analysis

The outcomes were the identification of common themes. All responses for each question were copied and pasted from MS Word to MS Excel. The ten areas were reviewed for common themes within. These were independently identified by two different researchers reading independently and identifying ideas and patterns in the data. Each interview was then reviewed and coded for identified recurrent themes. Key themes were then discussed with the research team. Quotes that best illustrate important representation of participants' views and experiences identified are presented in the findings.

9.4.3 Findings

In total, 70 practices were nominated. Of these, 45 were selected for geographic, ethnic and socioeconomic diversity of their practice population. From these, 26 (58%) agreed to be interviewed, one of which withdrew their consent prior to the interview being booked. Of these 25 practices 22 practices were interviewed (51%), the last three were not interviewed due to logistic reasons. In all cases, the key participant in managing the immunisation delivery for that practice was interviewed. See Table 9.3 for the identified common themes.

Table 9.3: Common themes identified from general practices who obtain high childhood immunisation coverage in their registered population

Theme	Comments /examples (*quotes in italics)*
1. Staff and staff support	
Staff engagement/commitment	*It is top [priority]* *All the staff are passionate*
The PN as critical in the practice immunisations and target attainment	*Important part of the nurse's role* *All nurses as authorised vaccinators and regularly supported to attend education and updates*
Immunisation specific and /or flexible time provision	Standard time allocation for vaccination event 15-20 minutes, but flexibility to go up to 30 minutes Regular ring-fenced time for precall,recall, auditing and meetings *Nurse need time to do things opportunistically*
Effective teamwork	*Good working collaboratively* *Everyone's input is equal*
Immunisation a regular focus in meetings	Importance of having dedicated staff who will keep it a focus
Importance education focus for front line staff	Part of staff orientation Practice commitment to regular, ongoing training for all vaccinators, peer support *[we] take all education opportunities on offer*
Staff personal beliefs	All staff fully vaccinated
2. Connection and communication with clients/families/community	
Engagement with Lead Maternity Caregivers to establish early contact	*Personal interactions with independent midwives* *Midwife is self-employed but part of [the general practice]*
Effective engagement with families antenatally or soon after birth	Use of notification from the NIR Sending greetings for engagement following being informed of birth *Congratulations phone call to all new mums* *Send a congratulations letter*
Broadening accessibility for immunisation services	Examples include: extended evening hours, often weekend mornings, use of pick up services: a free 'healthtaxi', taxi travel voucher
Creativity in building and maintaining relationships /rapport with clinents and their broader family	Baby-friendly hand-outs pre and during immunisation visits, incentives/rewards for vaccinating, health promotion days, services to other family members, home visits, engaging with other agencies, photos at immunisation visits, multiple ways of supporting in the vaccination event – range of distraction techniques eg bubbles, stickers, stamps, parent participation encouraged . Free breakfast, supermarket vouchers *..;[I] proactively look in the waiting room..* Correspondence to caregivers *warm, welcoming and friendly* and *short and to the point*

Theme	Comments /examples (quotes in italics)
3. Effective use of internal systems, processes and electronic tools	
Use of timely precalls , appointment reminders and/ or prebooking	Use of a mix of text-2-remind, letters and phone At least weekly checking of recalls *Appointments are made at each visit for the next visit* *…phone or text if they don't make an appointment by the end of the week they turn the milestone age*
Effective and accurate use of the EMR database and data and messaging transfer	Knowledge , good process and systematic use of all of the mandatory data fields and outcome codes. Familiarity with NIR/PMS interface
Circumspect use of the outcomes codes 'declined' and 'non-responder'.	*[first] having a discussion with parents* *Ring when the next immunisation is due "are you still declining for [x]* *Always ask* Use of tasks to nurse on the EMR to contact parents Use of decline forms
4. Actively seeking difficult to find children	
Reducing missed opportunities	Use of PMS, patient dashboard and alerts so awareness at every visit that a child is due/overdue *have to be really sick to walk away without giving immunisation* *book for other siblings not here today*
Active management of those overdue	Any child who is overdue is actively re-called until the parent or care giver declines vaccine
Use of broader network knowledge from the database	Use the practice database to contact other extended family members *Trace family members through family tree* Front desk always ask '*are you still at…"*
Engagement with local child and family organisations	Contact with other local health and social services (Plunket, TamarikiOra, local Māori Health providers, Pacific community health providers, Community Health Workers, Family Start).
Using multiple approaches	*Even mention [the vaccination is due] when I see them in the dairy or shops*
Connecting with Outreach Immunisation Services	Systematic referral processes used
5. The role of immunisation targets and performance monitoring	
A focus on achieving targets	*Coverage levels discussed at team meetings* Use of PHO performance dashboard

9.4.4 Discussion

Practices that maintain high immunisation coverage have a range of strategies for their achievement. However there were common themes that can be identified consistently across these practices.

The first theme was the importance of the staff and the practice commitment to their staff. Staff support and commitment to the work of immunisation, their abilities to work as a team and to effectively communicate together contributed to high performance in a practice.

The second theme was engagement of the practice with the population they serve: Successful practices showed the desire and ability to develop effective communication and engagement in a range of thoughtful and proactive ways. This study revealed multiple local creative ways of engagement from internal practice approaches focusing on making the immunisation event a positive experience, reaching out proactively to others such as observing those in the waiting room, engagement with other local providers, and education and promotional events for their population.

The third common theme was the effective use of practice systems and interfaces for all aspects of identifying their population, engaging in a timely fashion, chasing those who have not received timely services, opportunistically identifying unmet needs and monitoring and responding to practice targets.

The fourth theme was around ways to actively seek out those children who were not routinely coming in for their regular vaccination events. These practices actively utilised a range of systems and referral options to find and offer services to these children.

The final theme was the active use and interest in achieving targets and engagement in the use of performance monitoring.

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9.5 Next steps: Translating best practice research to reduce equity gaps

9.5.1 Background

Working with the manger of our research and innovation team, Dr Lynn Taylor, we used the findings of the ‘Best Practice at the Practice’ research to design an intervention study. We wished to translate these learnings from high performing practices across to other practices where immunisation coverage and timeliness of delivery was lower. This study is titled *Translating Best Practice Research to Reduce Equity Gaps in Immunisation* and it gained HRC funding in July 2014. I am the Principal Investigator, my co-investigators are Dr Lynn Taylor and Helen Petousis-Harris. Lynn is also the project manager and Angela Chong the research assistant.

9.5.2 Methods

We have designed a randomised controlled intervention study, using a stepped wedge design methodology, with the aim to determine whether knowledge gained from general practices with high childhood immunisation coverage rates and timeliness of delivery, can be translated into strategies and actions in practices with low immunisation coverage, and in doing so lead to a successful increase in their childhood immunisation rates, timeliness of delivery and reduction in immunisation inequalities.

9.5.3 Results

This study is currently underway with health delivery partners of the Bay of Plenty DHB, Counties Manukau DHB, Eastern Bay of Plenty Primary Health Alliance, Te Tai Tokerau and Manaia PHOs. We look forward to completing this study in 2015.

9.6 Summary of Chapter 9

This chapter focused on using the knowledge obtained through previous research and putting interventions into place. I firstly presented an RCT designed to deliver an intervention focused on early engagement and effective pre-call messages to caregivers of young infants. The outcomes of this study were limited, mainly due to the overall high immunisation rates in the region at the time of delivery, but it did show that early engagement and effective pre-call are effective for timely delivery of the first immunisation event. Importantly, this study also showed that infants who are not enrolled early with a general practice are much more likely to be unimmunised or underimmunised. I then presented the results from a qualitative study identifying the key themes in general practices that have been successful in immunisation service delivery, to look at commonalities of enablers and barriers. Finally I presented the design of a study for applying the learnings from high performing practices to other general practices to see whether this can improve their immunisation coverage and timeliness of delivery. Results from this study will be available in 2015.

CHAPTER 10 SUMMARY AND CONCLUSIONS: THE CONTRIBUTORY FACTORS THAT AFFECT CHILDHOOD IMMUNISATION COVER IN THE NZ SETTING

10.1 Outline of Chapter 10

This thesis has presented the history of the changes in immunisation coverage for the NZ infant schedule national vaccines since the early 1990s, the associated international literature that is pertinent to issues that affect immunisation coverage, and the body of research in which I have been involved over this time that is pertinent to immunisation coverage and timeliness of delivery.

This chapter summarises the major findings from the overall thesis and makes final conclusions.

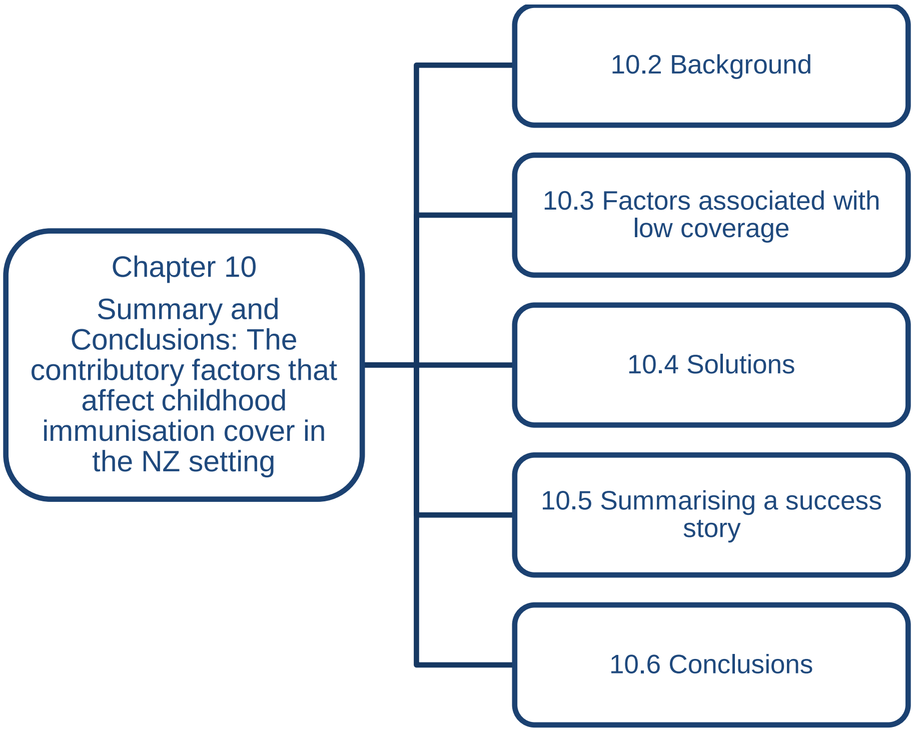
Chapter 10
Summary and Conclusions: The contributory factors that affect childhood immunisation cover in the NZ setting
10.2 Background
10.3 Factors associated with low coverage
10.4 Solutions
10.5 Summarising a success story
10.6 Conclusions

Figure 10.1: Outline of Chapter 10

10.2 Background

Childhood immunisation programmes are internationally well recognised as one of the most cost-effective activities in healthcare (85,86). Immunisation has eliminated smallpox from the world since 1979, is close to eliminating polio, and has delivered huge reductions in rates of other significant childhood diseases, such as measles, pertussis, diphtheria, hepatitis B, and *haemophilus influenza type b*. The gains stand to be even higher if universal high coverage in the delivery of NIPs is achieved for all these vaccines.

The population effectiveness of an immunisation programme can be measured by measuring immunisation coverage, which is the percentage of individuals in a total target population who have received all of the vaccines on the recommended national immunisation schedule for their age. Coverage is important to record and monitor, to enable us to gauge the effectiveness of an NIP. It is also used to identify high-risk subpopulations that may be missing out.

In NZ, prior to 1991, there were no standard national reported measurements of childhood immunisation coverage. In 1991-1992, NZ undertook a survey to officially measure immunisation coverage for children. This revealed that less than 60% of all children were fully immunised at the age of two years. Furthermore there were significant equity gaps showing much lower rates for children from backgrounds of poverty and specific ethnic groups; particularly Māori children. There were even lower immunisation rates for timeliness of delivery of immunisation events in the infant schedule with the same equity gaps patterns.

Further NZ coverage reports through the 1990s continued to report the low immunisation coverage, poor timeliness of delivery, and equity gaps for certain groups; in particular Māori children, Pacific children, children in households that were more mobile, children of immigrant families, and children in households living in economic poverty. There were also geographical variations, with a tendency to higher coverage in the more southern regions of the country. Across three surveys from 1991 to 2005, the significant predictive factors for under immunisation were household poverty, younger age of the principal caregiver, delayed start to the immunisation programme, later birth order in the family, ethnicity of principal caregiver being Māori or Pacific, and high mobility of families, with household mobility increasing by a factor of around ten percent through this period.

These surveys also reported on aspects of the knowledge and attitudes of parents/caregivers. In particular, caregiver belief in the importance of vaccination dropped by a factor of around 10% over this period, while a belief that immunisation was unnecessary if a child was healthy increased by over 10%. Those who would choose to delay due to mild illness were initially well over two thirds of caregivers interviewed. This dropped to just under 10% through this period.

From 2005, the implementation of the NIR enabled the more effective measurement of immunisation coverage. As was shown in Figures 2.1, 2.16 and 2.17, from this time there was a progressive improvement in recorded immunisation coverage, with the biggest gain from 2007. Alongside this, there was a reduction in the traditional equity gaps and improvement in timeliness of delivery, with the biggest gains seen from 2011.

10.3 Factors associated with low immunisation coverage

From the international literature reviewed and the research presented in this thesis, it is apparent that the ability to obtain and maintain high immunisation coverage in a community has an interwoven mixture of factors related to the environment, the family and community context, the political context, the healthcare system and the healthcare providers. These can be grouped into three broad areas:

1. Family/child and community characteristics that include socioeconomic issues, ethnicity issues, parent and child characteristics, social supports, access issues, family context, family beliefs and confidence and trust in the providers.

2. Provider and system-associated factors that include provider knowledge, attitudes, teams, provider systems, use of systems and resourcing of services.
3. Immunisation practice policy that includes governance, national schedules, funding and resourcing, policies and communication approaches.

Within the social and family contexts, the issues for families living in more economically deprived situations appear to create the most significant barriers to enabling update of immunisation for infants. Our NZ research particularly highlighted the sociocultural factors of single parent households, larger households, mobility, and geography (26).

The effects of economic deprivation are multiple and particularly include:

- Financial barriers to affording and physically accessing healthcare services.
- High mobility leading to reduce continuity of care.
- Loss of accurate records.
- Loss of personal relationships that can create lower trust with healthcare services.
- Lower parental literacy that can lead to reduced awareness and increase in misconceptions and fears.

While socioeconomic factors appear to be the stronger drivers (28), there are other allied factors associated with specific social mores, which can create challenges for indigenous groups, minority groups and immigrants. These can include language barriers, different cultural beliefs, lack of knowledge or engagement with the healthcare services, and lack of understanding of how to utilise services effectively.

Other community and family level issues include family health beliefs. However, these can frequently be driven by poor relationships or lack of effective contact with healthcare service design and, in reverse, good relationships with healthcare providers and accessible services can mitigate the effects of family health beliefs. Specific subgroups of children can be identified to be at higher risk of lower immunisation uptake; in particular preterm infants, children who have chronic or recurrent acute illness, children of younger mothers, and those with parents having lower education levels.

Families do not act in isolation and there are identifiable factors in communities that can affect immunisation coverage. For example some geographical or religious/belief communities may have high numbers of immunisation decliners as a community, or communities where confidence in the overall healthcare system may be low. These communities may be at more open to fears and concerns over vaccine myths and inaccuracies circulating in social media. Maintaining confidence in vaccines and immunisation programmes for communities is an important part of the mix. Public confidence is around maintaining trust, both at an individual level with families and healthcare providers, but also at the level of the media, the institutions, and government.

Adding to this is the effect of the greater environment on family knowledge and decision-making. Our research particularly highlighted the influences from messages in the media; particularly the headlines (17) and the way the messages are framed (16); as well as the timing in the life course, with a particular need to focus on the antenatal period (19).

10.3.1 Combined analysis

How important is each component part of the system? From our research we could explain the majority of variance in coverage and timeliness of delivery between NZ practices with these key areas:

- Factors associated with socioeconomic deprivation of the registered practice population.
- Early engagement with families, in particular early enrolment of the infant with the practice.
- Factors related to the general practice, the governance of the practice, the stability of the practice team, allowing enough dedicated time to key staff and effective use of practice systems.
- Factors related to the clinical staff, particularly the confidence and engagement of the staff and enough dedicated time.
- Factors related to the parent and what affects their decision-making in accepting immunisation, particularly in the antenatal period.
- Broader environmental influences from effects such as media and social networks.

10.4 Solutions

There are multiple barriers to obtaining and maintaining high immunisation coverage. However, these are identifiable and modifiable. A range of interventions have been shown to be effective, but require coordinated efforts, recognising the interconnected parts. Getting the delivery of effective immunisation services right for the community is a dynamic process of interaction between communities and the healthcare system (219).

10.4.1 Families/communities

There are multiple challenges to obtaining timely childhood immunisation for families, as noted above. A system can instigate mitigating factors to reduce or overcome these challenges. Such responses will be at many levels. Firstly, there exists the need for higher political commitment to reduce social and economic inequalities, work and social services' responses to security of incomes, employment and improving parental education. Secondly, there are healthcare services' responses with accessible healthcare services, effective health service engagement with the local communities and families, enrolment and continuity of care models that are sensitive to the families and communities and outreach services for those for whom the systems have failed to provide. Identifying the higher risk groups is an important step towards implementing strategies that are tailored and effective to the needs of specific subpopulations that face greater challenges.

Our research identified a mixed picture of positive and negative attitudes towards immunisation amongst NZ parents. An important minority of parents lack confidence in the programme, expressing fears over perceived side effects, lack of perceived concerns over the effects of the diseases, desire for more and better-presented information and a belief that healthy living will be sufficient. All these issues are likely to be creating barriers to uptake (9). Adding to these are external sources that create greater barriers for parents. An important example is parents being given misleading information in the antenatal period (9,11), the most important time for parents in terms of making decisions around immunising their children (19). We identified that parents are motivated to keep their children healthy and disease-free, but need support with decision-making to recognise underlying anxieties around the purposes of immunisation for their own child and the relevance to their own family situation. Good tools and resources, particularly in the very important antenatal period, can positively support parents in this process (20). Much of the learning from our research with parents has been used in resource development, such as informed consent tools, MoH promotional resources and strategies, DHB resources, IMAC resources, and used in national provider education and training programmes.

The importance of having a trusting relationship with the provider appears to be a major feature in supporting effective, engaged, and on-going uptake of services. Hence, mobility of families, late enrolment, poor record-keeping, and lack of sharing records are likely to create barriers for the families in accessing services and being appropriately supported in their decision-making. The use of the NIR and the more recent national focus on effective birth enrolment for all children are examples of a policy response to these issues.

The participation of the family is also dependent on broader confidence in the issue. Strategies within the policy and public health service delivery, that include maintaining effective relationships with key media influences, are likely to positively influence the confidence and clarity of communication in the broader environment.

10.4.2 Providers

Despite all the barriers at the family and community level, it is clear that effective health care systems that support high functioning providers can significantly mitigate the challenges on families from the environmental and social issues. As Sabnis et al expressed in 2003, the characteristics of the vaccination provider were likely to be *more closely associated with vaccination coverage levels that were the characteristics of the family and child* (135). The provision of sufficient providers, resourced with adequate knowledge and positive attitudes, are all part of this. Provider communication skills, attitudes and confidence are likely to be the most important factors for maintaining trusting relationships with families and imparting confidence in the safety and purpose of the immunisation programme.

Underpinning this, providers need an adequate overall knowledge level, both to maintain their own confidence and also not to miss opportunities to offer vaccinations, particularly via misunderstanding true contraindications (12,13). Provider education needs to be supported by appropriate resourcing, information and promotional materials such as effective websites, and in the NZ context, the Immunisation Handbook and the free national advisory phone line (0800 IMMUNE) (22).

Finally, providers are more effective in functioning teams, adequately resourced, with shared commitment to the issue, enough time to do the work, good working relationships, and clear roles (14,22,30). Much of our research on providers has been used to support NZ service delivery; particularly to develop and improve vaccinator-training courses and updates, GP training and updates, informed consent tools, and support to the 0800 national phone line. Overall, while gaps remain, provider knowledge has improved confidence in delivery has improved, and the systems to support them have become more standardised through this period.

10.4.3 Systems/Organisation

The main drivers for change and maintenance of effective services are likely to be the higher level organisational factors in the healthcare system, a mixture of leadership, effective and adequate resourcing, political management, community engagement, and maintenance of agency credibility. At the level of the vaccination provider, a well-working system drives high immunisation coverage (23,25). Key aspects of this include effective population enrolment, supply and costs, good information systems, record keeping, tracking, and continuity of care (25,30,). Factors that negatively impact on the functioning of systems are provider loss of confidence in its effectiveness, as is seen when data or records are not available or inaccurate; resourcing constraints; challenges with multiple providers; and poor data-sharing.

It is important to be aware that there can be gaps between perceptions and the functioning realities with the systems. Competing demands and different priorities can affect outcomes (27). The important factors that help or hinder immunisation uptake can be delineated, as we have done at the practice level, by identifying the features of ‘best practice’ and translating this knowledge and experience across to other practice settings (34). Applying the learning from our research does produce useful results, as we have shown with a systematic delivery of effective early enrolment and good engagement that improves timeliness of delivery of the infant vaccination programme (31).

10.4.4 Data collection/tools

Underpinning effective systems is good data collection, analysis, and use. It is necessary to know the population being served, so that those being missed out can be identified and offered appropriate services, both at an individual and at a collective level.

The greatest challenge for many immunisation delivery systems is to define the denominator - create the ability to know its population and then offer effective continuity of care through from antenatal to post-natal, including effective record-keeping and family prompts. The development of the NIR was a vital tool for the NZ system to measure, monitor and respond to immunisation coverage. The ability of the systems at the general practice level to enable providers to systematically enrol, precall, recall, and audit all the children in a population has played a major role in creating an effective system in the NZ setting (25,23) and, conversely, poor design of systems can maintain errors or be more open to misuse with inexperienced operators (214).

10.4.5 Policy and advocacy

The policy environment underpins and drives responses to the above issues. For example, my earliest research on this topic was undertaken in response to a concern that policy change affected immunisation coverage at the six-week event (7). The results showed that removing the six-week immunisation event from the general practice Well Child check had a negative impact on immunisation uptake, demonstrating the important role of policy in affecting uptake.

In the early 1990s, the NZ environment did not nurture high immunisation coverage. Since then, successive national reports and strategic documents have been developed, leading to policy changes implemented throughout this period. The first step in this progression required recognition there was a problem that required both a national and a local response.

Policy responses included multiple responses at all levels of the healthcare service delivery. Progress was shown to be slowly occurring from the time of the first report in 1993, further assisted by the instigation of effective measuring, monitoring and feedback tools (the NIR).

My early contribution to the policy focus was in 2000. I worked with colleagues in public health and the MoH to delineate the challenges and barriers to improving immunisation coverage (8). This article included a synthesis of the international literature at the time, focused on strategies to improve coverage. Important components of the recommendations from this article were included in the MoH document "An integrated Approach to Infectious Disease: Priorities for action 2002 – 2006" published in 2001 (54), followed by the publication of the strategic directions intent 2003 to 2006 (55). These included more support for a coordinated national strategy, the need to develop a national register, and greater focus on services for children hard to access.

The real surge in progress appeared from 2007, which coincided with creation of national health targets. While it appears to have been the national health target that primarily drove this improvement, I suggest that this national health target was built upon the earlier work of recognising and defining the problem and being able to measure it. As a result, by 2007, there was an engaged health community committed to action, with the knowledge and tools to be able to effect change, which brought about the political buy-in. Hence, the timing was right to be able to effectively respond to the national targets. National targets alone will not be effective, unless they are underpinned by commitment, knowledge, expertise and resourcing of the community required to deliver them.

10.5 Summarising a success story

In 2012, it was my privilege to be able to publish the story of improved immunisation coverage in NZ, the closure of the equity gaps and the reasons behind this progress (32) The early strategies had failed to gain much traction until core steps were in place; in particular, the implementation of the NIR as the tool for supporting delivery, reporting and monitoring. The NIR is particularly important for its ability to monitor and give feedback to the different service levels in real time. Once the key tools were in place, the 2008 government launch to make immunisation coverage one of the ten key public health priorities (subsequently reduced to six), was seen as a strong driver for action in the sector, propelled by regular public feedback of progress, including regular media publications comparing and contrasting the achievements of all the DHBs. Goal-setting and the ability to measure and monitor progress were seen as fundamental to the improvement. The three broad areas that needed changes:Family and child characteristics, environmental issues, and systems and provider practices, are recognised as interwoven in the solutions.

10.5.1 Family and child characteristics

It has long been recognised that receiving the first immunisation event on time is one of the strongest and most consistent predictors of subsequent complete immunisation (193). Our research expanded upon this to identify the antenatal period as a crucial time for parental decision-making and to develop good engagement with the HCP. Hence, strategies around supporting parents in the antenatal period (20), alongside effective early enrolment and engagement (31), are likely to be important elements in a successful system.

10.5.2 Environmental issues

Children coming from more vulnerable families or environments, particularly lower socioeconomic and some ethnic groups, are well recognised as challenging for all immunisation programmes. What our research has highlighted is that primary care service delivery that is well supported and encouraged by the wider political and healthcare environment, and integrated with an effective outreach component, can effectively deliver to high needs groups and overcome the traditional equity gaps in these populations.

Other environmental challenges include the broader community concerns that can be inflated with modern media which impacts both on parent and provider confidence (17). NZ has always been seen as having an active anti-immunisation voice in the traditional and social media networks. The research I have outlined in this thesis has shown that this voice is likely to have lessened, or become more marginalised, over more recent years. I suggest this is likely to be due to all of us within the health sector being more committed to the issue, communicating confidently at different levels and to different audiences. Supporting this are providers working closely with the media, being available and accessible to the media; recognising that media drivers are, at times, different from public health programme needs (15).

10.5.3 Systems and provider practices

Our research identified a range of barriers at the service delivery level, the most important of which were structural and organisational aspects. The most significant factors are the age of enrolment of the infant, with earlier enrolment the better; the type of PMS and the presence of a stable practice with low staff turnover. Secondly, the functioning of the healthcare team, having well-supported staff with dedicated time for immunisation service delivery and with positive, engaged relationships with the children and their families is important. Thirdly, the healthcare professionals themselves need to feel both confident and knowledgeable. While gaps in knowledge are important to address, it is likely that the confidence to communicate effectively with parents is the more critical factor. I conclude from our research that a confident, engaged healthcare professional, working in a supportive stable team and given enough time and resources, can utilise effective systems to maximise effective enrolment, precall, and recall, and take every opportunity to reduce missed opportunities to immunise when children are in the practice. A challenge to maintain high immunisation coverage is the competing priorities in primary healthcare and hence, the importance of continuing to support immunisation champions within every level of the system to keep the focus and prioritise attention.

10.5.4 Future directions

The work is not completed. While NZ, at the time of this thesis, has maintained high immunisation coverage and significant closure of traditional equity gaps, there is still a way to go to reach ideal targets of 95% and higher. Further areas of research that I intend to pursue to support effective immunisation uptake include continuing a focus on integrated service delivery. This includes further applied research on translating best practice models into service delivery, and further attention to integrated models, in particular, the role of outreach services alongside general practice services. More research needs to be considered around the role of communication and, in particular, the effectiveness of the provider/parent interface role. Currently, the place of fathers and other important family members within this discussion has not been well considered.

10.6 Conclusions

Immunisation programmes need to pay attention to gaining and maintaining high immunisation coverage and timeliness of delivery to be most effective. NZ has come from a background of mediocre immunisation coverage in their childhood programme to achieving high coverage rates, better timeliness of delivery, and closure of the traditional equity gaps. Prioritising immunisation at the national and district levels, with goals and priorities and having the right tools to measure coverage, public reporting and feedback loops and supporting an educated and confident provider workforce appear to have underpinned the progress.

The components that need to be in place to make this happen include a mixture of factors from the broader political and health service setting, provider systems and characteristics, factors associated with the families and their children, and other environmental issues, such as general community awareness and communication as driven via traditional and social media.

From this research, it is evident that it is important to place a focus on the antenatal period to engage and support parents; maximise effective systems at the national, regional and local service delivery levels that particularly include attention to early enrolment, engagement, precall, audit and prioritisation of immunisation in the provider environment; support providers with effective education and good working environments encouraging and supporting champions and, with the wider environment create greater community confidence in immunisation, working with social networks and the broader media.

The final caveat is that, although NZ has made excellent strides with relatively limited increase in resourcing, it is yet to reach the target of 95% fully immunised and on time. Whether the current strategies will be adequate to continue progress or if further strategies need to be considered, such as increasing incentives to providers, incentivisation approaches for parents or large mass media campaigns, remain to be seen.

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Improving immunisation coverage: what needs to be done?

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New Zealand has failed to achieve immunisation coverage targets and prevent recurring epidemics of vaccine-preventable diseases, such as measles and pertussis. Available estimates suggest that there has been no improvement in coverage since 1996, despite at least partial implementation of four of the five elements of the 1995 National Immunisation Strategy (*Immunisation 2000*). The fifth element, an immunisation surveillance system, has not yet been developed. Synthesis of evidence-based reviews identified interventions likely to improve coverage: (1) effective reminder and recall systems covering all children, (2) outreach systems to follow up children who do not respond to recall, (3) feedback of provider performance based on effective measurement of coverage, (4) financial incentives to providers and/or parents to increase demand for immunisation, (5) entry checks of immunisation at schools and early childhood centres, (6) education to promote immunisation, and, most importantly, (7) a national immunisation coverage surveillance system to enable implementation and evaluation of the other recommended strategies. An increase in resourcing and strong health professional commitment are also vital for success.

Childhood immunisation is one of the most cost-effective activities in healthcare.[1] In New Zealand, immunisation has eliminated wild polio,[2] and controlled tetanus and diphtheria,[2] but epidemics of measles,[3-5] rubella,[6] and pertussis[7,8] continue as a result of inadequate coverage. Although invasive *Haemophilus influenzae* type b (Hib) disease has been reduced by over 90% since the addition of Hib vaccine to the schedule in 1994,[9] other countries have virtually eliminated the disease through immunisation.[10] In 1998, the first case of diphtheria for 19 years[2] raised concerns that low immunisation coverage could allow the return of previously controlled diseases. There have not been any studies to measure the national impact of hepatitis B immunisation on rates of carriage. However, as Maori and Pacific Islands children have only about 60% coverage against hepatitis B,[11] it is likely that only about half the potential gains are being achieved. Cases of acute hepatitis B have declined since the 1980s, but rates have levelled off since 1995.[12]

Despite concerns about coverage, there is no reliable national coverage information apart from the 1992 survey.[13] Coverage estimates, based on immunisation benefit claim data, suggest that there has been no improvement in coverage since 1996.[14] The 1995 National Immunisation Strategy (*Immunisation 2000*) failed to achieve its target of 95% of two year old children fully immunised by the year 2000.[15] We examined recent reviews of immunisation coverage to identify appropriate interventions to raise coverage levels.

Low immunisation coverage and poor coverage surveillance

The 1992 national survey found that less than 60% of children were fully immunised by the age of two years.[13] The survey was designed to define the lower bound of coverage by only accepting a written record of immunisation. Furthermore, coverage for individual vaccine series was about 80%, excluding the 18 month episode. For Maori and Pacific Islands children, coverage was only 42% and 45%, respectively. A repeat coverage survey in 1996 in the Northern region found a small improvement, with an overall coverage rate of 63%, and rates of 45% for Maori and 53% for Pacific Islands children.[11]

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Immunisation benefit claims have been used to estimate national coverage. A change to the claim form in 1994, which identified each dose in the series, improved the estimates,[14] but they remain unreliable for several reasons. Not all vaccinators complete claim forms. Although coverage estimates are adjusted for children in practices which do not claim, accurate data on the numbers of these children have not been available. The low level of payment for the immunisation benefit (less than the cost to the practice),[17] compared to a claim for a medical service, may encourage a claim for the latter instead of the former. Providers may simply mark an episode with a single tick under one vaccine, even though three vaccines were given at the episode. At the time of the 1996 immunisation schedule change, the relative order of the hepatitis B and DTPH vaccines on the claim form changed and there was a corresponding change in the relative coverage estimates for the two vaccines. As the primary purpose of the claim form is to claim the benefit rather than provide information, there isn't a strong motivation for providers to check the accuracy of the information on the form. Nor is the accuracy checked elsewhere. Finally, the coverage estimate is calculated from the number of claims divided by the target population and does not distinguish catch-up doses, that is, vaccine given to those outside the target age range. Nor is there any adjustment if the same child receives the same vaccine from another vaccinator.

Coverage estimated from claims improved up to 1996, but since then there has been no further improvement. Estimates for the years 1997-99 have remained below those for 1996.[14] During the last few years, there have been increased concerns about vaccine safety, highlighted by the unfounded allegations about measles-mumps-rubella vaccine (MMR) causing autism and bowel disturbances.[18] There have also been changes in the funding and delivery of health services, increased uncertainty about the numbers of children who are in capitated practices which do not claim the immunisation benefit, possibly increased numbers of children who do not have a regular general practitioner, and no increase in the immunisation benefit payment despite increases in other medical services payments. However, the relative contribution of these factors to the apparent lack of improvement in coverage is unknown.

Other sources have found higher coverage. The Plunket National Child Health Study followed up 4286 children born in 1990-91 and found that 83% were fully immunised by the age of two years.[19] However, the validity of these findings was questioned because of the high loss to follow-up.[20] A cohort study in Christchurch[21] and an independent practitioner association in Rotorua,[22] both recently reported over 90% of children fully immunised by the age of two years. The Rotorua estimate was calculated based on children enrolled with providers rather than all children in the area.

Health authorities have recognised the need to raise immunisation coverage. The Public Health Commission convened an expert group on immunisation,[23] and advised the Minister of Health on recommended strategies in October 1993.[24] The Minister called for further policy work, which led to the 1995 National Immunisation Strategy composed of five elements:[25]

- a simplified immunisation schedule
- immunisation certificates for entry to school/early childhood centre
- standards for immunisation providers
- local immunisation co-ordination
- improved immunisation surveillance.

Several elements in the Public Health Commission's advice to the Minister were not included in the strategy. These elements included establishing the position of a national immunisation co-ordinator, exploring the use of financial incentives and feedback of performance to improve the commitment of providers to immunisation, exploring ways of reducing the indirect cost barriers, and increasing the kind and range of resources to educate parents about immunisation.[24]

By the time the strategy was launched, the decisions on the schedule had already been made, and some local co-ordinators were already in place. The immunisation standards had been developed, but no resources were made available for audit. Therefore, in effect the only really new strategies with potential to improve coverage were the *Health (Immunisation) Regulations 1995*, which require immunisation checks on entry to an early childhood centre or school, and the planned development of immunisation surveillance. As the surveillance system failed to materialise, and no resources were made available for implementation of the *Health (Immunisation) Regulations 1995*, it is perhaps not surprising that coverage has not improved.

This failure is in sharp contrast to the improvements in coverage in Britain,[25] the United States,[26] and Australia.[27] Australia introduced a national immunisation register in January 1996 to provide a recall and reminder system, improved surveillance, and an information base for provider and parent financial incentives. The proportion of two year old children fully immunised increased from 64% to 85% during the following two years.[27] New Zealand is now performing poorly compared to other Western countries and the Pacific Islands (*Table 1*).[28]

Table 1: *Coverage estimates for pertussis immunisation*[1]

Country	Percent immunised	Year of estimate
Niue	100	1998
Samoa	100	1998
Tokelau	100	1998
Sweden	99	1995
Canada	97	1998
France	97	1997
Tonga	97	1998
Cook Islands	95	1998
United States	94	1995
United Kingdom	93	1998
Australia	85	1998
New Zealand	81	1998
New Zealand	83	1999

Note: 1 All data, except those for New Zealand, are from reference 28. The New Zealand data are from reference 14.

Interventions to improve immunisation coverage

There is an increasing body of evidence on interventions to improve immunisation coverage. This evidence has been reviewed in New Zealand and overseas to identify strategies to improve coverage. We assessed and synthesised these evidence-based reviews to generate strategies relevant for New Zealand.

Evidence-based reviews: The New Zealand Department of Health's Health Research and Analytical Services used interviews and the literature to identify strategies to improve coverage among low coverage groups.[29] They identified the need to:

- increase the cultural appropriateness of services
- improve education and information, especially for caregivers
- implement comprehensive and effective follow-up and recall systems for all children.

A 1994 Canadian review, based on an overview of 54 comparative trials and expert opinion, recommended school entry legislation and an immunisation surveillance system with recall for childhood immunisation.[30] The authors considered the evidence insufficient to recommend consumer-based interventions or provider-orientated recommendations.

In 1999 the United States National Vaccine Advisory Committee reviewed American immunisation programmes, strategies and financing, published studies, and reached consensus conclusions.[31] They made 15 recommendations grouped around four categories:

- financing to remove cost barriers

- provider practices to ensure the implementation of recall/reminder systems and office-based assessment of coverage levels
- information systems for monitoring disease, vaccination coverage, and immunisation delivery performance
- support for communities and families to ensure that the public is aware of the importance of vaccination, resources are focused to help underserved children, and citizen coalitions can advocate for improvements in the immunisation delivery system.

Another 1999 United States review of 197 published international studies recommended:[32]

- increasing community demand by client reminder and recall systems, multi-component interventions including education, and immunisation entry requirements for early childhood centre, school and college
- enhancing access to vaccination services by reducing costs for immunisation, expanding access to immunisation clinics as part of multi-component intervention, immunisation programmes in food support programmes, and home visits
- provider-based interventions, notably, provider recall and reminder systems and assessment and feedback of provider performance.

In 1999, the New Zealand National Health Committee published a review recommending 12 strategies based on interviews with key informants within New Zealand and a review of literature.[33] The relevant strategies include:

- the need for a population-based focus
- more equitable distribution of funding within the primary care sector
- ensuring that every child is enrolled in primary care and followed up
- development of outreach immunisation services
- increased performance-based incentives for immunisation in primary care settings
- increased resources to help compliance with the *Health (Immunisation) Regulations 1995*
- a promotion campaign tailored to the 'hard to reach'
- reliable individual and national coverage information.

Synthesis and recommendations: Seven recommendations were identified that captured the recommendations of the reviews that are relevant to New Zealand (*Table 2*). The first recommendation, the establishment of a national immunisation coverage surveillance system, has a role in implementing and/or evaluating the other six recommended strategies.

Table 2: Interventions recommended for New Zealand, source(s) of the recommendation, and the role of a national immunisation coverage surveillance system

Intervention	Source of recommendation[1]	Role of national immunisation coverage surveillance system
Effective reminder and recall systems, with every child on a primary care register	HRAS,Can,NVC, UST,NHC	Enhance enrolment on provider-based reminder/ recall systems
Coordinated outreach systems to follow up children who do not respond to recall	HRAS,UST,NHC	Identify children not covered by provider-based systems and those who have missed immunisation
Feedback of provider performance, based on effective measurement of coverage and peer comparison	UST	Measure coverage at provider, regional and national level
Financial incentives to providers and /or parents to increase demand for immunisation	UST (parents) NHC (providers)	Provide mechanism for calculating incentives
Immunisation check at entry to schools and early childhood centres	Can, UST, NHC	Provide back-up source of individual immunisation information and means to analyse coverage at school entry
Education to promote immunisation, using a variety of channels	HRAS,NVC,UST, NHC	Enable targeting and evaluation of interventions

Note: 1 HRAS, Health Research and Analytical Services, New Zealand, 1993[29]
Can, Canadian review, 1994[30]
NVC, National Vaccine Advisory Committee, United States, 1999[31]
UST, United States taskforce, 1999[32]
NHC, National Health Committee, New Zealand, 1999[33]

Discussion

Despite a major policy initiative with the 1995 National Immunisation Strategy, New Zealand has failed to achieve immunisation coverage targets. In addition, there remains uncertainty about the actual level of coverage. Comparing the evidence-based strategies to the New Zealand policy, it is apparent that this poor outcome has arisen from a number of failures. The most important was the failure to implement an immunisation surveillance system. Without a population-based system, it is not possible to ensure that every child is on a reminder/recall system, to arrange co-ordinated outreach, to give feedback of provider performance, or to offer financial incentives.

The *Health (Immunisation) Regulations 1995* have not achieved their intended outcome of increasing the priority that families give to the completion of immunisation. The reason for this requires further analysis, but may be related to inadequate resourcing of the policy. In contrast to the effective strategies in other countries, there has not been any substantial additional funding to achieve the New Zealand coverage targets.

The central role of an immunisation coverage surveillance system is highlighted in *Table* 2. Whatever the configuration of this system, it will require practice level and national level information processes. Computerised immunisation coverage systems offer other potential advantages, such as surveillance of vaccine-related adverse events.[34] Most importantly, without reliable coverage information it will be difficult to evaluate the effectiveness of any strategy. Once a national immunisation coverage surveillance system is established and reliable data are available, further strategies could be implemented, based on evidence of effectiveness and depending on need.

Britain, the United States and Australia have all been successful in improving immunisation coverage. If New Zealand is to achieve similar success, it will need to implement effective strategies, increase resourcing, and develop a strong health professional commitment to immunisation.

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Surveillance and control notes

Indigenous spread of murine typhus in the Auckland area

A case of murine typhus was notified in the Auckland area in April. The case had not travelled overseas during the incubation period of the disease. This is the seventh case of indigenously acquired murine typhus notified in New Zealand. All seven cases have been in the Auckland area: five in the Northwest Auckland Health District and two in the South Auckland Health District. All cases were confirmed serologically. The first of the cases occurred in 1989, and four have occurred within the last two years.

Typhus is a rickettsial disease. The classical (epidemic) louseborne typhus is a serious illness, which without treatment has a fatality rate of up to 40%. It is caused by *Rickettsia prowazekii*. Murine (endemic) fleaborne typhus is caused by *R typhi*, and is a worldwide zoonotic disease. Humans are incidental hosts, with fleas transmitting the organism from a reservoir of small mammals such as rats and cats. A feature of the seven indigenously acquired cases was their exposure to possums, which have been implicated as reservoir hosts.

The incubation period for murine typhus is approximately 1-2 weeks. The predominant clinical features are headache, fever, chills and myalgia, and a macular or maculopapular rash develops in about half the cases. Untreated, the illness persists for 2-3 weeks, and medical attention is often sought for the prolonged fever. Early diagnosis is based on clinical suspicion, and should be considered in patients with these signs and symptoms, particularly those with an appropriate exposure history (eg, rats and possums). Ideally, suspected cases should be discussed with, or seen by, an infectious diseases specialist as the features of this infection are non-specific and the differential diagnosis extensive. While the clinical course is usually uncomplicated, an intensive care admission rate of 10% has been reported and the case-fatality rate is 1-4%. The usual means of laboratory confirmation is rickettsial serology, which is available from the Virology and Immunology Laboratory at Auckland Hospital. Other forms of typhus include the miteborne scrub typhus and the tickborne typhus fevers (eg, spotted fever). All rickettsial diseases are notifiable.

Outbreak of salmonellosis linked to a butchery

In July 1999, eight cases of salmonellosis, due to *Salmonella* Typhimurium phage type 135, were linked to produce from a Christchurch butcher's shop. Six of the cases had consumed cocktail saveloys from the shop. Four of these six cases were members of one family who had eaten some of the saveloys without heating them. The other two cases who ate the saveloys were young children who had been given saveloys during visits to the shop. The seventh case had bought mince patties from the butchery and cooked the patties at home. The eighth case was a member of the butchery staff, who reported eating a variety of meats, but not saveloys, from the butchery.

S Typhimurium phage 135, at a concentration of 540 organisms per gram, was isolated from the interior of left-over saveloys collected from the family's fridge. The level of contamination at the time of consumption may have been higher, as this count was estimated after the saveloys had been frozen and thawed twice during the course of successive laboratory testing. No mince patties were available for testing.

The saveloys were made on the butchery premises. An investigation of the premises found them to be in reasonable condition, but very old and too small for mass production of cooked product. While no specific cause for the contamination could be proven, it is most likely that meat grossly contaminated with *Salmonella* was used in the production of both the saveloys and meat patties. The temperature reached during the cooking of batches of saveloys was tested during the investigation and found to be sufficient to kill *Salmonella* when the saveloys were fully immersed (74.5°C for >10 seconds). However, some of the saveloys floated above the surface of the water and therefore possibly received insufficient heating. Batches of cooked saveloys were sometimes held at ambient temperatures for periods long enough to allow any remaining viable *Salmonella* to multiply to high levels. In addition to the practices that probably contributed to this outbreak, there was cross contamination between raw and cooked products in the butchery, for example, the saveloys were displayed next to crumbed raw chicken, with no physical barrier between them, and there were crumbs on the saveloys.

There is a need for HACCP-based food safety programmes in butcheries, especially those preparing and handling cooked products. Following the identification of control point failures in this butchery, several recommendations were made:

- saveloys and other precooked sausages should be weighted or held under the water to ensure even cooking of the whole batch, and a temperature probe should be used to verify adequate cooking of each batch (*Table 1*)
- there should be a system to ensure that the cooked product does not remain at room temperature for more than two hours before being refrigerated
- the practice of giving customers, especially children, precooked smallgoods for immediate consumption should be discontinued
- there should be a physical barrier between precooked product and raw meats, and no-touch techniques (eg, using plastic bags) should be used when picking up all meats.

(Reported by Rosemary Whyte, Microbiologist, ESR; Barry Armstrong, Health Protection Officer, Crown Public Health; Chris Graham, Microbiologist, ESR.)

Table 1: Time and temperatures required for a 6.5D kill of Salmonella in meats and smallgoods manufacture[1]

Temperature °C	Time
55	89 minutes
60	12 minutes
65	85 seconds
70	11 seconds
71.1	10 seconds

Note: 1 From the United States Code of Federal Regulations 9

Sexually transmitted infections in 1998

Surveillance of sexually transmitted infections (STIs) in New Zealand has been based on data supplied by sexual health clinics. Since the surveillance is limited to clinics, the results may not be representative of the epidemiology of STIs in the New Zealand general population.

The rates of STIs in 1998 cannot be compared with those in previous years because the denominator data used to calculate the rate have changed. In 1998, the rates were expressed as a percentage of all patient visits to sexual health clinics. In previous years, rates were expressed as a percentage of only the new patients attending sexual health clinics, that is, patients who had not visited a clinic in the previous three months. This change has the effect of appearing to reduce the rates of disease. Therefore, when making comparisons between 1998 and previous years, the number of cases, not rates, should be used.

The STIs diagnosed in each clinic and nationally in 1998 are shown in *Table 2*. Genital warts continued to be the most common STI diagnosed among patients attending sexual health clinics (4.7% of patients), followed by *Chlamydia* (3.0%) and genital herpes (1.0%). Between 1997 and 1998, there was an increase in the number of cases of both *Chlamydia* (13.7% increase from 1994 to 2268 cases) and gonorrhoea (12.7% increase from 292 to 329 cases). The number of cases of genital herpes and syphilis remained constant, while cases of genital warts decreased by 6.3% (from 3711 to 3479 cases). There were no cases of lymphogranuloma venereum, granuloma inguinale or chancroid reported in 1998. Trichomoniasis is no longer reported.

Females were more likely to attend sexual health clinics than males (56.5 vs 43.5%). Rates of all STIs were higher in male than female patients: *Chlamydia* (3.3 vs 2.9%), gonorrhoea (0.6 vs 0.3%), genital warts (5.5 vs 4.0%), genital herpes (1.2 vs 0.8%) and syphilis (0.05 vs 0.02%).

Fifty-one percent of clinic attendees were aged 15-24 years. Rates of *Chlamydia* and gonorrhoea were highest in those aged 15-19 years, genital warts rates were highest in those aged 20-24 years, genital herpes rates were highest in those aged 30-34 years, and syphilis rates were highest in those aged 45 years and older. Male sexual health clinic attendees diagnosed with *Chlamydia*, gonorrhoea, genital warts or genital herpes were significantly older than the female attendees diagnosed with these diseases.

Europeans accounted for 74% of clinic attendees, Maori 14% and Pacific Islands people 3%. Rates of *Chlamydia* were considerably higher in Maori (7.3%) and Pacific Islands people (7.1%) than in Europeans (2.1%). A similar pattern was seen for gonorrhoea (1.6% for Maori, 1.9% for Pacific Islands people and 0.2% for Europeans). Rates of genital warts were similar in the three main ethnic groups, whereas rates of genital herpes were highest in Europeans.

Table 2: Sexually transmitted infections by sexual health clinic, 1998

Number of new cases[1] ☐ Percent patient visits[2] ▨

Disease	Cases[1] and current rates[2] by clinic																								
	Whangarei	Auckland[5]	Hamilton/Tokoroa	Tauranga	Rotorua	Whakatane	Taupo	New Plymouth	Gisborne	Napier	Hastings	Wanganui	Palm North/Levin	Wellington[6]	Lower Hutt	Porirua	Nelson	Blenheim	Greymouth	Christchurch	Ashburton	Timaru	Dunedin	Invercargill/Gore	Total
Chlamydia[3]	53 4.0	523 2.6	346 4.6	111 3.3	97 7.1	45 5.7	48 6.7	142 5.9	46 3.8	52 5.5	35 5.4	31 3.4	127 3.4	208 1.7	39 3.5	56 7.8	19 1.7	10 2.1	6 1.8	161 1.9	7 3.0	21 5.0	51 1.6	34 3.1	2268 3.0
Gonorrhoea[3]	4 0.3	137 0.7	25 0.3	2 0.1	37 2.7	12 1.5	3 0.4	1 0	16 1.3	5 0.5	12 1.9	5 0.6	2 0.1	39 0.3	3 0.3	5 0.7	1 0.1	0 0	0 0	11 0.1	0 0	2 0.5	6 0.2	1 0.1	329 0.4
Genital herpes	11 0.8	160 0.8	88 1.2	27 0.8	26 1.9	6 0.8	17 2.4	24 1.0	5 0.4	16 1.7	6 0.9	15 1.7	45 1.2	130 1.1	13 1.2	7 1.0	16 1.4	1 0.2	3 0.9	68 0.8	1 0.4	15 3.6	20 0.6	11 1.0	731 1.0
Syphilis	0 0	8 0	3 0	1 0	1 0.1	0 0	0 0	0 0	0 0	2 0.2	0 0	0 0	0 0	5 0	2 0.2	0 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	1 0.1	24 0
Genital warts	64 4.8	996 4.9	372 5.0	117 3.5	93 6.8	40 5.0	21 2.9	139 5.8	28 2.3	58 6.2	56 8.7	43 4.8	176 4.7	389 3.2	74 6.7	37 5.1	78 7.0	41 8.6	11 3.4	416 5.0	7 3.0	34 8.1	135 4.2	54 4.9	3479 4.7
Total patient visits[4]	1336	20452	7494	3360	1360	794	716	2390	1206	942	644	902	3710	12260	1102	722	1116	476	328	8390	234	418	3222	1084	74716

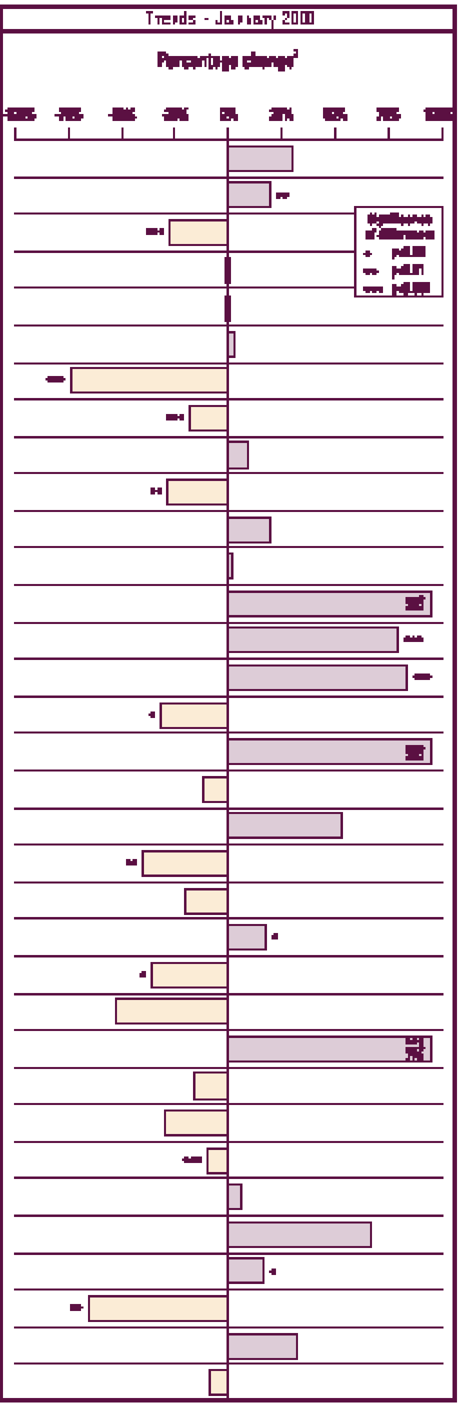
Notes: 1 Data are based on the diagnoses made at sexual health clinics
2 Based on cases diagnosed, expressed as a percentage of all patient visits
2 Confirmed cases only
4 Number of patient visits for any reason July-December 1998, multiplied by two
5 Based on data from three Auckland clinics
6 Based on data from two Wellington clinics

Surveillance data

National surveillance data - January 2000

Disease[1]	Current year - 2000[2]			Previous year - 1999		
	Jan 2000 cases	Cumulative total year-to-date	Current rate[2]	Jan 1999 cases	Cumulative total year-to-date	Previous rate[2]
AIDS	0	0	0.0	0	0	0.7
Acute gastroenteritis[4]	40	40	16.5	45	45	13.8
Campylobacteriosis	1002	1002	230.0	880	880	314.5
Cholera	0	0	0	0	0	0
Creutzfeldt-Jakob disease	0	0	0	0	0	0
Cryptosporidiosis	10	10	25.0	57	57	25.1
Dengue fever	0	0	0.2	2	2	0.7
Giardiasis	120	120	40.1	140	140	50.0
H influenzae type b disease	2	2	0.3	0	0	0.3
Hepatitis A	3	3	3.0	13	13	4.2
Hepatitis B (acute)[5]	15	15	28	5	5	24
Hepatitis C (acute)[5]	8	8	27	5	5	27
Hydatid disease	0	0	0.2	0	0	0.1
Influenza[6]	1	1	22.0	2	2	12.2
Lead absorption	8	8	4.2	0	0	23
Legionellosis[6]	5	5	1.0	4	4	28
Leprosy	0	0	0.2	0	0	0.1
Leptospirosis	0	0	1.7	1	1	20
Listeriosis	4	4	0.6	0	0	0.4
Malaria	4	4	1.2	5	5	20
Measles	10	10	3.0	8	8	3.8
Meningococcal disease	25	25	14.0	25	25	11.0
Mumps	3	3	1.5	5	5	23
Paratyphoid	0	0	0.2	3	3	0.5
Pertussis	233	233	35.1	7	7	4.0
Rheumatic fever	4	4	1.7	7	7	20
Rubella	2	2	1.1	1	1	1.5
Salmonellosis	00	00	52.3	250	250	50.5
Shigellosis	10	10	3.8	18	18	3.6
Tetanus	0	0	0.1	1	1	0.1
Tuberculosis	25	25	12.2	36	36	10.4
Typhoid	2	2	0.3	1	1	0.8
VTEC/STEC infection	3	3	1.8	1	1	1.4
Yersiniosis	54	54	13.2	78	78	14.5

Trends - January 2000



Notes: 1 No cases of the following notifiable diseases were reported in January: anthrax, brucellosis, cysticercosis, diphtheria, meningoencephalitis - primary amoebic, plague, poliomyelitis, rabies, rickettsial diseases, trichinosis, viral haemorrhagic fever, or yellow fever

2 These data are provisional

2 Rate is based on the cumulative total for the current year (12 months to January 2000) or the previous year (12 months to January 1999), expressed as cases per 100 000

4 Cases with suspected common source, often in a high risk category (eg, foodhandler, childcare worker, healthcare worker)

5 Only acute cases of this disease are currently notifiable

6 Surveillance data is based on laboratory reported cases only

7 Percentage change is the difference between the number of cases in the current year (12 months to January 2000) and the previous year (12 months to January 1999). This difference is expressed as a percentage of the number of cases in the previous year

Surveillance data

Surveillance data by health district - January 2000

Cases this month ☐ Current rate[1] ▨

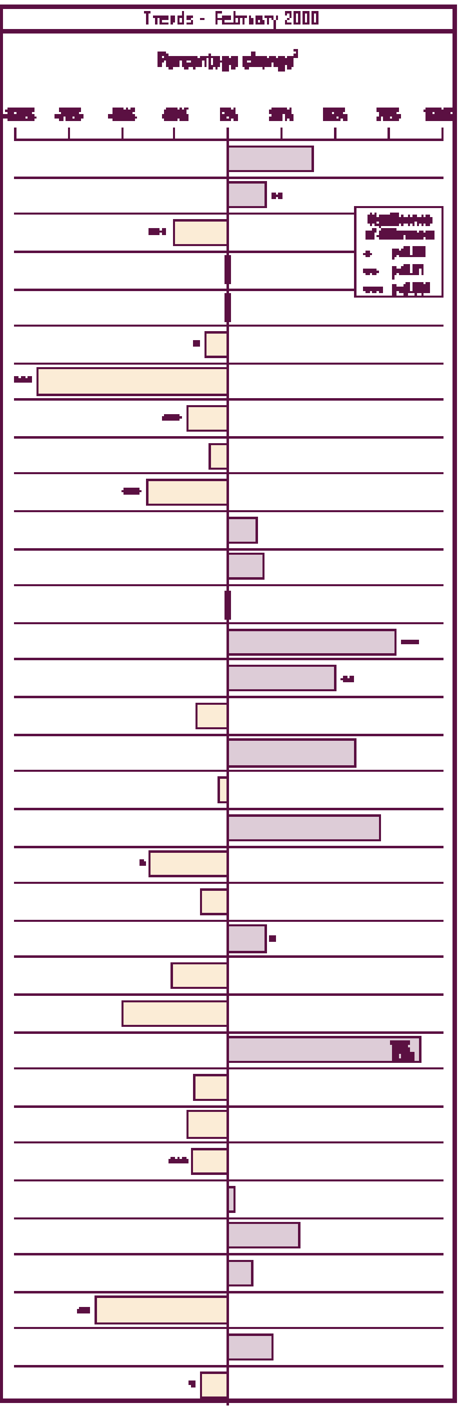
Disease	Cases for January 2000,[2] and current rate[1,2] by health district[3,4]																							
	Northern				Midland								Central							Southern				
	Northland	NW Auck	Central Auck	South Auck	Waikato	Tauranga	Eastern BoP	Gisborne	Rotorua	Taupo	Taranaki	Ruapehu	Hawkes Bay	Wanganui	Manawatu	Wairarapa	Wellington	Hutt	Nelson-Marl	West Coast	Canterbury	South Cant	Otago	Southland
AIDS[3]	0				0								0							0				
	1.4				0.4								1.2							0.4				
Acute gastroenteritis	1	5	8	7	5	1	0	1	0	0	0	0	0	0	0	0	2	1	0	0	9	0	0	0
	14.6	20.3	27.8	14.0	8.3	2.7	0	87.4	1.5	0	9.4	0	3.5	0	0	0	8.6	3.8	5.1	6.2	57.9	7.5	0.6	4.5
Campylobacteriosis	23	85	73	57	60	21	2	12	12	4	27	5	38	12	28	11	73	33	29	4	220	59	78	37
	124.7	234.6	254.5	178.5	260.1	131.2	95.5	142.1	162.7	123.8	166.6	107.4	284.3	149.8	127.0	197.6	319.5	248.8	155.2	148.0	323.9	367.1	256.0	203.0
Cholera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Creutzfeldt-Jakob disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptosporidiosis	1	1	1	2	0	1	0	0	0	0	0	0	1	0	0	0	2	1	0	0	2	2	2	3
	12.4	10.4	8.4	9.1	55.9	24.8	6.0	17.5	1.5	13.0	13.1	6.0	48.1	11.4	41.2	31.2	21.8	47.5	6.0	9.3	51.7	76.7	15.6	25.2
Dengue fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.5	0.6	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0.6	0
Giardiasis	3	24	19	9	12	6	0	2	2	4	0	3	6	1	0	0	6	1	3	2	11	2	3	1
	30.6	58.3	72.6	39.2	67.1	67.4	19.9	41.5	27.9	78.2	23.4	35.8	82.2	22.8	38.6	23.4	58.9	30.9	36.9	67.8	47.3	26.4	30.1	29.6
H influenzae type b disease	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.5	0.6	0.6	0	0.9	0	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0.8	0	0	0
Hepatitis A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
	9.5	3.8	5.5	7.0	0.7	0.9	0	6.6	3.1	0	0	0	2.1	1.6	1.3	0	4.9	1.5	1.7	0	0.8	1.3	1.2	1.8
Hepatitis B	0	0	4	0	2	0	0	1	0	0	0	0	1	0	1	0	0	2	0	0	2	2	0	0
	3.6	1.0	2.3	3.5	5.3	1.8	0	4.4	3.1	3.3	0	6.0	6.3	1.6	1.3	0	1.6	4.5	1.7	0	4.4	6.3	1.2	1.8
Hepatitis C	0	0	0	0	0	2	0	0	2	0	0	0	2	0	1	0	0	0	0	0	0	0	1	0
	2.9	0.3	1.4	0.6	0	15.1	4.0	0	15.5	0	0	0	2.8	0	1.3	0	1.6	0.8	0	6.2	8.8	6.3	2.9	0
Hydatids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.3	0	0	0.9	0	2.2	0	0	0	0	0	0	0	5.2	0.4	0	0.9	0	0	0	0.6	0
Influenza[5]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	1.5	18.0	29.2	35.4	31.4	0.9	33.8	10.9	4.6	3.3	10.3	0	7.0	13.0	3.3	10.4	11.1	0	18.0	9.3	62.3	22.6	13.3	8.1
Lead absorption	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	5	1	0	0
	2.9	0.5	2.3	0.9	6.9	0.9	2.0	4.4	6.2	0	3.7	0	10.5	0	5.3	7.8	4.5	2.3	0.9	12.3	9.6	17.6	1.7	1.8
Legionellosis[5]	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
	0.7	0	1.2	0.6	6.3	0.9	2.0	0	0	3.3	1.9	6.0	1.4	1.6	1.3	10.4	1.6	3.8	0	0	4.4	0	1.2	0.9
Leprosy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.3	0.9	0	0	0	0	0	0	0	0	0.7	0	0.7	0	0	0.8	0	0	0	0	0	0
Leptospirosis	1	1	0	0	3	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0
	7.3	0.8	0	0.3	3.3	0.9	0	4.4	1.5	3.3	3.7	0	5.6	3.3	2.7	0	0.8	0	1.7	6.2	0.8	6.3	0.6	0.9
Listeriosis	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
	0.7	1.0	1.4	0.6	0.7	0.9	0	0	1.5	0	0	0	0	0	0.7	0	0.4	0.8	0.9	0	0.8	0	0	0
Malaria	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
	2.9	0.3	1.4	0.9	1.3	0	2.0	2.2	1.5	0	0	0	0.7	4.9	1.3	0	0.4	0.8	2.6	0	2.3	0	2.3	0
Measles	0	1	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	1	1	1	0	0	0	1
	0.7	2.0	2.3	2.9	1.0	0.9	2.0	4.4	0	3.3	0	0	8.4	0	6.6	7.8	3.3	5.3	2.6	12.3	2.6	1.3	7.5	2.7
Meningococcal disease	0	2	4	5	4	1	1	0	0	0	1	0	0	1	0	1	1	0	1	0	1	0	1	1
	27.7	11.2	21.1	32.2	11.9	14.2	23.9	13.1	26.3	22.8	6.6	6.0	12.5	9.8	1.3	13.0	5.8	12.1	1.7	0	9.1	2.5	12.2	17.1
Mumps	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
	1.5	0	1.2	2.0	0	0.9	0	0	3.1	9.8	3.7	0	4.9	1.6	2.0	2.6	2.1	1.5	0.9	3.1	1.0	0	2.9	0.9
Paratyphoid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.3	0	0.6	0.3	0	0	0	0	0	0	0	0	0	1.3	0	0.4	0	0	0	0.3	0	0	0
Pertussis	5	36	7	12	11	6	0	0	0	0	1	0	3	0	0	0	15	8	24	4	74	12	10	5
	13.9	28.4	9.0	14.6	21.5	10.6	0	4.4	0	0	15.9	0	14.6	3.3	2.0	0	26.8	18.9	73.7	12.3	70.4	129.5	41.1	278.5
Rheumatic fever	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	8.8	0	2.0	3.8	1.7	3.5	2.0	13.1	4.6	3.3	0.9	6.0	0.7	0	0	2.6	1.6	1.5	0	0	0	0	0	0
Rubella	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2.9	1.3	0.6	0.9	0	0.9	0	0	0	0	0	0	1.4	0	0.7	2.6	1.2	0	2.6	6.2	0.3	0	5.2	0.9
Salmonellosis	2	5	11	9	13	4	1	0	1	0	0	1	2	0	10	0	6	0	2	0	15	6	8	3
	35.0	49.0	46.6	38.0	54.9	44.3	25.9	48.1	46.5	42.3	38.4	77.6	47.4	19.5	85.1	72.8	74.1	60.3	48.0	30.8	60.5	84.2	59.1	75.5
Shigellosis	0	2	1	2	1	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	8.8	4.1	9.8	10.0	2.3	0.9	2.0	2.2	10.8	6.5	0.9	0	0	0	2.7	2.6	2.1	3.0	0	0	1.0	2.5	0	1.8
Tetanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	2.2	0	0	0	0	0.7	0	0	2.6	0.4	0	0	0	0	0	0.6	0
Tuberculosis	0	3	5	3	4	0	0	0	0	0	0	0	1	1	2	0	3	0	0	0	2	0	1	0
	18.2	10.4	28.3	20.2	11.2	11.5	4.0	4.4	1.5	3.3	0	0	12.5	6.5	8.0	0	19.8	18.9	5.1	3.1	7.0	3.8	3.5	3.6
Typhoid	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.8	0.3	0.6	0	0.9	0	0	0	0	0	0	0	0	0	0	0	1.5	0	0	0	0	0	0
VTEC/STEC infection	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
	0	0	1.2	0.3	10.6	4.4	0	2.2	1.5	3.3	1.9	0	0	0	0.7	2.6	2.1	1.5	0	0	1.6	0	1.7	0
Yersiniosis	1	7	12	6	3	1	0	0	1	0	0	0	4	0	0	0	3	4	4	1	6	1	0	0
	10.2	14.2	19.1	14.9	11.9	5.3	8.0	8.7	10.8	13.0	6.6	0	14.6	3.3	4.0	2.6	16.9	18.9	5.1	30.8	20.7	27.7	1.2	6.3

Notes: 1 Current rate is based on the cumulative total for the last 12 months expressed as cases per 100 000
2 These data are provisional
3 AIDS data given by divisions of the Health Funding Authority
4 Further data are available from the local medical officer of health
5 Surveillance data based on laboratory-reported cases only

Surveillance data

National surveillance data - February 2000

Disease[1]	Current year - 2000[2]			Previous year - 1999		
	Feb 2000 cases	Cumulative total year-to-date	Current rate[3]	Feb 1999 cases	Cumulative total year-to-date	Previous rate[3]
AIDS	3	3	0.1	2	2	0.8
Acute gastroenteritis[4]	34	80	16.6	38	83	14.2
Campylobacteriosis	883	1883	232.3	762	1041	312.5
Cholera	0	0	0.0	0	0	0.0
Creutzfeldt-Jakob disease	0	0	0.0	0	0	0.0
Cryptosporidiosis	10	30	24.0	82	130	26.0
Dengue fever	0	0	0.1	4	6	0.8
Giardiasis	165	386	47.0	207	347	50.5
Haemophilus influenzae type b	0	2	0.3	1	1	0.3
Hepatitis A	3	6	2.5	22	35	4.0
Hepatitis B (acute)[5]	5	20	2.8	7	12	2.5
Hepatitis C (acute)[5]	8	17	2.8	6	11	2.4
Hydatid disease	0	0	0.1	3	3	0.1
Influenza[6]	5	6	22.1	4	6	12.4
Lead absorption	13	21	4.0	18	27	2.7
Legionellosis[6]	7	12	2.0	6	10	2.3
Leprosy	0	0	0.2	2	2	0.1
Leptospirosis	8	17	1.8	5	6	1.0
Listeriosis	3	7	0.7	2	2	0.4
Malaria	7	11	1.2	7	12	2.0
Measles	8	17	3.1	4	12	3.5
Meningococcal disease	24	48	14.0	23	48	12.0
Mumps	7	10	1.7	1	6	2.2
Paratyphoid	1	1	0.2	1	4	0.5
Pertussis	325	558	43.0	7	14	4.0
Rheumatic fever	7	11	1.8	5	12	2.1
Rubella	0	2	1.0	1	2	1.3
Salmonellosis	150	257	50.1	276	526	60.1
Shigellosis	15	26	3.8	17	35	3.7
Tetanus	0	0	0.1	1	2	0.1
Tuberculosis	36	61	12.0	40	76	10.8
Typhoid	4	6	0.3	3	4	0.8
VTEC/STEC infection	7	10	1.7	8	10	1.4
Yersiniosis	50	110	13.0	64	142	15.0



Notes:
1 No cases of the following notifiable diseases were reported in February: anthrax, brucellosis, cysticercosis, diphtheria, meningoencephalitis - primary amoebic, plague, poliomyelitis, rabies, rickettsiosis, viral haemorrhagic fever or yellow fever
2 These data are provisional
3 Rate is based on the cumulative total for the current year (12 months to February 2000) or the previous year (12 months to February 1999), expressed as cases per 100 000
4 Cases with suspected common source, or person in a high risk category (eg, foodhandler, childcare worker/healthcare worker)
5 Only acute cases of this disease are currently notifiable
6 Surveillance data is based on laboratory reported cases only
7 Percentage change is the difference between the number of cases in the current year (12 months to February 2000) and the previous year (12 months to February 1999). This difference is expressed as a percentage of the number of cases seen in the previous year

Surveillance data

Surveillance data by health district - February 2000

Cases this month ☐ Current rate[1] ☐

Disease	Cases for February 2000,[2] and current rate[1,2] by health district[3,4]																							
	Northern				Midland								Central							Southern				
	Northland	NW Auck	Central Auck	South Auck	Waikato	Tauranga	Eastern BoP	Gisborne	Rotorua	Taupo	Taranaki	Ruapehu	Hawkes Bay	Wanganui	Manawatu	Wairarapa	Wellington	Hutt	Nelson-Marl	West Coast	Canterbury	South Cant	Otago	Southland
AIDS[3]	1				0								2							0				
	1.3				0.4								1.5							0.3				
Acute gastroenteritis	0	0	2	4	2	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	20	1	0	0
	14.6	19.0	27.2	15.5	8.9	3.5	0	87.4	1.5	0	9.4	0	3.5	0	0	0	9.5	3.8	4.3	6.2	57.9	8.8	0.6	4.5
Campylobacteriosis	13	94	90	70	73	11	5	8	8	3	12	4	35	9	24	8	89	34	25	5	108	44	48	63
	127.7	242.0	264.6	185.0	264.7	130.3	79.5	150.8	164.3	130.3	162.8	125.4	284.3	159.6	133.6	210.6	329.8	244.3	164.6	151.1	305.2	384.7	248.4	235.4
Cholera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Creutzfeldt-Jakob disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptosporidiosis	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	3	2	0	0
	11.7	10.4	8.7	8.2	51.2	22.2	6.0	17.5	1.5	13.0	13.1	0	41.1	9.8	37.9	28.6	18.9	28.7	6.0	6.2	52.0	79.2	13.9	25.2
Dengue fever	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0.3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0
Giardiasis	3	31	33	8	17	4	0	2	0	1	2	0	11	3	3	1	18	8	0	0	14	2	3	1
	29.9	60.6	75.8	35.4	64.8	62.1	15.9	41.5	27.9	78.2	20.6	35.8	76.7	26.1	36.6	26.0	57.2	33.9	34.3	52.4	46.6	25.1	28.4	23.4
H influenzae type b disease	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.5	0.6	0.3	0	0.9	0	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0.8	0	0	0
Hepatitis A	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	2.2	2.8	5.8	6.1	0.3	0.9	2.0	6.6	3.1	0	0.9	0	2.1	1.6	1.3	0	4.1	0.8	1.7	0	0.8	1.3	1.2	0.9
Hepatitis B	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	4.4	0.5	2.3	3.2	5.6	2.7	0	4.4	3.1	3.3	0	6.0	6.3	1.6	0.7	0	1.6	4.5	1.7	0	4.1	6.3	1.2	1.8
Hepatitis C	1	1	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
	3.6	0.5	1.2	0.6	0	16.0	4.0	0	13.9	0	0	0	4.9	0	1.3	0	1.6	0.8	0.9	6.2	8.3	6.3	2.9	0
Hydatids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	2.2	0	0	0	0	0	0	0	5.2	0.4	0	0	0	0	0	0.6	0
Influenza[5]	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0
	1.5	18.3	29.2	35.4	31.1	0.9	33.8	10.9	4.6	3.3	10.3	0	6.3	13.0	3.3	10.4	10.7	0	18.0	9.3	62.3	22.6	15.1	8.1
Lead absorption	0	0	0	0	3	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	3	2	1	0
	2.9	0.5	2.0	0.3	7.6	0.9	2.0	4.4	4.6	0	4.7	0	8.4	0	6.0	7.8	4.1	0.8	1.7	12.3	9.6	17.6	2.3	0.9
Legionellosis[5]	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
	0	0	1.2	0.3	7.3	0.9	2.0	0	0	3.3	1.9	6.0	1.4	1.6	0.7	10.4	1.6	3.8	0	0	4.7	0	1.2	0.9
Leprosy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0.3	1.2	0	0	0	0	0	0	0	0	0.7	0	0.7	0	0	0.8	0	0	0	0	0	0
Leptospirosis	1	0	0	0	2	1	0	0	0	0	1	0	2	0	1	0	0	0	0	0	1	0	0	0
	8.0	0.5	0	0	3.6	1.8	0	4.4	1.5	3.3	4.7	0	6.3	3.3	3.3	0	0.4	0	1.7	6.2	1.0	5.0	0.6	0.9
Listeriosis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	0.7	1.3	1.4	0.6	0.3	0.9	0	0	1.5	0	0	0	0	0	0.7	0	0	0.8	0.9	0	0.8	1.3	0	0.9
Malaria	0	0	1	2	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
	2.2	0.5	1.7	1.2	1.3	0	4.0	2.2	0	0	0	0	0.7	3.3	2.0	0	0.4	0.8	2.6	0	2.3	0	1.7	0
Measles	1	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	0	1	1	0
	1.5	2.0	2.3	2.9	0.7	0.9	2.0	4.4	0	6.5	0	0	9.1	0	6.6	5.2	2.9	4.5	4.3	12.3	2.3	2.5	8.1	2.7
Meningococcal disease	1	1	1	5	4	0	1	0	0	0	0	0	1	1	0	0	1	1	0	0	3	0	4	0
	27.7	10.4	20.8	32.5	13.2	13.3	25.9	13.1	24.8	22.8	5.6	6.0	12.5	9.8	1.3	10.4	4.9	12.1	1.7	0	9.8	2.5	13.3	16.2
Mumps	0	0	1	2	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
	1.5	0	1.4	2.6	0	1.8	0	0	3.1	9.8	4.7	0	5.6	1.6	2.0	2.6	1.6	1.5	1.7	3.1	1.0	0	2.9	0.9
Paratyphoid	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.3	0	0.6	0.3	0	0	0	0	0	0	0	0	0	1.3	0	0.4	0	0	0	0.3	0	0	0
Pertussis	8	46	13	41	20	4	1	0	0	0	3	1	2	0	2	1	15	15	40	1	96	1	13	2
	20.4	40.1	12.7	26.3	28.4	13.3	2.0	4.4	0	0	18.7	6.0	16.0	3.3	3.3	2.6	32.5	30.2	106.3	15.4	95.2	129.5	48.1	280.3
Rheumatic fever	4	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	11.7	0	2.0	3.5	2.0	3.5	2.0	8.7	4.6	3.3	0.9	6.0	0.7	0	0	2.6	1.6	1.5	0	0	0	0	0	0
Rubella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2.9	1.0	0.6	0.9	0	0.9	0	0	0	0	0	0	1.4	0	0.7	2.6	1.2	0	2.6	6.2	0.3	0	5.2	0.9
Salmonellosis	2	12	10	13	12	6	2	1	5	0	0	0	3	0	10	12	7	5	6	1	25	11	10	6
	29.9	45.2	43.4	31.9	51.6	46.1	27.8	39.3	52.7	29.3	31.8	59.7	44.6	17.9	80.5	93.6	66.7	51.3	48.0	27.8	59.2	86.8	57.9	74.6
Shigellosis	0	2	2	1	1	0	1	1	0	4	0	0	0	0	0	0	1	1	0	0	0	0	1	0
	8.0	4.3	9.5	8.2	2.6	0.9	6.0	4.4	10.8	16.3	0.9	0	0	0	2.0	2.6	2.5	3.8	0	0	0.8	2.5	0.6	0.9
Tetanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	2.2	0	0	0	0	0.7	0	0	2.6	0	0	0	0	0	0	0.6	0
Tuberculosis	1	7	5	9	2	1	0	0	1	0	0	0	0	0	0	0	2	3	0	0	3	0	1	1
	19.0	11.2	28.6	22.2	10.2	11.5	4.0	2.2	3.1	3.3	0	0	11.2	8.1	7.3	0	16.9	19.6	5.1	3.1	5.7	2.5	4.1	2.7
Typhoid	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.7	0.8	0.9	0.9	0	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VTEC/STEC infection	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
	0	0	0.9	0.3	9.6	3.5	0	2.2	1.5	3.3	1.9	0	0	0	0.7	0	2.1	1.5	0	0	2.6	0	1.7	0
Yersiniosis	1	6	7	3	5	3	2	1	2	1	0	0	7	0	1	0	4	1	2	2	7	4	0	0
	8.0	12.9	18.5	14.0	13.2	8.0	9.9	10.9	13.9	13.0	6.6	0	18.1	3.3	4.7	2.6	16.9	18.9	6.9	33.9	17.1	27.7	1.2	6.3

Notes: 1 Current rate is based on the cumulative total for the last 12 months expressed as cases per 100 000
2 These data are provisional
3 AIDS data given by divisions of the Health Funding Authority
4 Further data are available from the local medical officer of health
5 Surveillance data based on laboratory-reported cases only

Public health abstracts

Reinfection can be the major cause of recurrent tuberculosis

A study in an area of Cape Town, South Africa, with a high rate of tuberculosis (1000 cases per 100 000), found that reinfection with a second strain of *Mycobacterium tuberculosis* (exogenous reinfection), rather than reactivation of the primary infection (endogenous reactivation), was the major cause of recurrent tuberculosis. The study was conducted between 1992 and 1998, and included patients who had at least two episodes of postprimary pulmonary tuberculosis, with cultures from two episodes available for DNA fingerprinting and with cure as the outcome of the first episode. Sixteen patients were included in the study. For 12 of the 16 cases, restriction fragment length polymorphism analysis showed the isolates from the two episodes were different, indicating that reinfection was the cause of the recurrence (Van Rie A, Warren R, Richardson M, et al. Exogenous reinfection as a cause of recurrent tuberculosis after curative treatment. N Engl J Med 1999; 341: 1174-9).

Editorial note: Before the availability of antituberculosis treatments, it was assumed that the recurrence of active tuberculosis in a person previously infected was usually due to reactivation rather than reinfection. In this era of effective treatment regimes, it is becoming apparent that reinfection may play a major role in recurrent tuberculosis. However, the relative roles of reinfection and reactivation probably vary depending on the prevalence of the disease. In areas of high prevalence most recurrent cases probably result from reinfection, whereas in areas of low prevalence reactivation may be the more likely cause. In 1999, 39 (8.6%) of the 451 cases of tuberculosis notified in New Zealand were recorded as 'reactivations'. These cases would include both reactivations and reinfections.

Little change in smoking trends among pregnant women in the United States

A study in the United States has found that the decline in smoking among pregnant women between 1987 to 1996 reflects the decline in smoking initiation among women of childbearing age, rather than an increase in quitting rates related to pregnancy. The smoking behaviours of pregnant women were compared with those of non-pregnant women 18-44 years old. Women were surveyed by telephone each year between 1987 and 1996. Among all the women interviewed, the proportion who had ever smoked decreased significantly ($P<0.05$) from 44.1% in 1987 to 38.2% in 1996. The prevalence of current smoking decreased significantly among both pregnant women (16.3 to 11.8%) and non-pregnant women (26.7 to 23.6%). Throughout the 10 years, pregnant women were about half (54%) as likely as non-pregnant women to smoke. The median number of cigarettes smoked per day remained fairly stable for pregnant smokers (10), but decreased significantly for non-pregnant smokers - from 19 in 1987 to 15 in 1996 (Ebrahim SH, Floyd RL, Merritt RK, et al. Trends in pregnancy-related smoking rates in the United States, 1987-96. JAMA 2000; 283: 361-6).

Editorial note: Exposure to tobacco during the prenatal period and to environmental tobacco smoke during the postnatal period are leading causes of mortality and morbidity among children. The fact that most smokers (54%) continued to smoke when they were pregnant highlights the need for further efforts to reduce the number of young women who begin smoking. While the overall prevalence of smoking in New Zealand has declined by 4 percentage points since 1985, there has been little decline in those younger than 35 years. A 1995-6 Plunket survey suggests that few women give up smoking during pregnancy. This survey reported that 26% of pregnant women (49% of pregnant Maori) smoked, compared with a 28.6% of all women 15-39 years (1996 Census).

Travel health

300 million cases of malaria a year

According to the World Health Organization (WHO), malaria is endemic in 100 countries or territories worldwide. Over the period 1982-97, an average of 25 million cases were reported to the WHO each year, with the large majority reported from Africa. The number of reported cases represents only a small proportion of the actual number of malaria cases. The WHO estimates that in 1998 there were almost 300 million cases of malaria, with over 1 million people dying from the disease. Almost 90% of these deaths occurred in Africa, south of the Sahara (Malaria, 1982-1997. Wkly Epidemiol Rec 1999; 74: 265-70).

Editorial note: Malaria is an important hazard for New Zealanders travelling to endemic areas. There were 46 cases notified in 1999, 21 of whom were New Zealanders travelling overseas on either business or holiday. These travellers most likely acquired their infections in Africa (6), Papua New Guinea (7), the Solomon Islands (2), India (2), and/or South East Asia (6). Based of the number of visits to these countries, the risk of acquiring malaria was highest for travel to Papua New Guinea and the Solomon Islands. Precautions against malaria are described in the Ministry of Health publication *Health advice for overseas travellers*. These precautions include malaria chemoprophylaxis and measures to avoid mosquito bites.

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Concerns of health providers and parents affect immunisation coverage

Nikki Turner

New Zealand has a disappointing record with immunisation coverage as we continue to languish with low immunisation rates, well below the targets set in earlier national strategies.[1] While there are currently no available national coverage data, the high background rates of pertussis disease alone suggest that coverage rates are unlikely to have improved much over the 1992 national coverage survey. This survey showed that less than 60% of children, and more alarmingly only 42% of Maori and 45% of Pacific children, were fully immunised by two years of age.[2]

Despite the disappointing national picture, local initiatives have shown it is possible to achieve and maintain higher coverage rates, such as those seen in Rotorua. These all take local flavour, but show the key characteristics of committed teams and integrated processes at the primary healthcare level.

The international literature reflects several clear themes on how to gain and maintain high immunisation coverage. These cover enhancing access and provider-based interventions and strategies to increase community demand.[3] Key aspects of delivery include financing the system effectively, focussing on provider practice, appropriate integrated information systems and community support.[3]

Possibly of greatest importance in the overall picture in obtaining high immunisation coverage is the role of the primary care providers – both their support and knowledge base appear to be vital ingredients for improving immunisation rates – and this may be a more important aspect than parental knowledge base.[4]

The excellent paper in this edition by Jelleyman and Ure demonstrates that health professionals in the Rotorua District express strong statements of support for immunisation, but hold significant underlying uncertainties.[5] Of note is that 11% of health professionals consider immunisation to have unacceptable dangers and a further 17% are unsure. Furthermore, over one third of health professionals were uncertain about the lack of association between autism and MMR. There is a well-established and vast scientific literature around immunisation risks and dangers and the particular issue of MMR/autism has been broadly discredited, [6] although continues to have a life through the media. The knowledge base and attitudes of health professionals do not appear to match their belief in the importance of science, and how little they consider themselves to be influenced by the media. This highlights the need for us as health professionals to be more discerning and to look more critically at our knowledge gaps and the influences building our attitudes.

Recent research in New Zealand looking at general practitioner knowledge and attitudes nationally has highlighted both significant knowledge gaps and the desire of health professionals for extra resources to support more effective communication with parents.[7] In this research, health professionals failed to recognise the importance of their own knowledge gaps and educational needs. The most significant barrier to raising coverage identified by GPs was parental concerns over vaccine safety and associated misconceptions. The second most significant barrier was the concern over lack of funding to providers. This is strongly backed by the international literature, which shows clear relationships between improved coverage and financial and quality support to health professionals. The inadequacy of the immunisation benefit subsidy, particularly to cover the costs of children who are harder to access, has been frequently highlighted.[8]

The antenatal period also needs focus as an important ingredient. New Zealand research has shown that the majority of mothers make their decision around immunisation in the antenatal period.[9] Furthermore, it has been shown that parents lack information in this period and wish to have more.[9] Jelleyman and Ure support this concern by showing the significant knowledge gaps and range of attitudes displayed by some antenatal providers. Will extra focus in this area make a difference? An interesting New Zealand study from 2001 (A Wroe, N Turner, unpublished data) demonstrated that giving increased information in the antenatal period with a decision-making aid does follow through to a significant increase in timely immunisation coverage in the infant.

The paper by Hamilton et al delineates the common themes from parents who chose not to vaccinate.[10] While there are no precise data, information to date suggests the anti-immunisation lobby to be in the order of 5–6% of the population.[11,12] This group has always been an active part of the New Zealand scene. The importance of this sector is not so much its existence, as its members remain a small percentage of the community, as its influence on the wider community, particularly as modern communication tools such as the Internet create much more effective and rapid access to wide networks. Local research has already demonstrated that there is a high level of misconception about the issues surrounding immunisation, with one in eight mothers not believing that vaccines are effective and a staggering one in five mothers (one in three of those under 24 years) believing that good hygiene and nutrition will prevent the diseases vaccinated against.[11]

It is hardly surprising that the most consistent message coming through from parental and health professional research is that one of the biggest barriers to achieving immunisation in New Zealand is parental fear.[7,13] This is also reflected in parents in the Maori community.[13] The parents of our most vulnerable children frequently have considerable logistic, financial and, at times, cultural barriers to overcome to complete an immunisation event. It does not take much to seed a degree of doubt or fear in a struggling parent to make the likelihood of achieving a full and timely course of immunisation even more remote.

Current strategy in New Zealand is appropriately being directed towards being able to track and offer services to the children who are missing out. However, until we also seriously tackle the considerable gaps in the needs of health professionals – both resource needs and knowledge gaps – we are unlikely to make much headway with addressing community-wide fears and misconceptions around immunisation and attitudes.

As New Zealand children, particularly Maori and Pacific, continue to suffer the terrible burden of meningococcal B disease the new MeNZB® vaccine is in the last phases of trials. Current data are looking positive and, if the trials continue to a successful completion, New Zealand can hope to see this vaccine introduced to all children under 20, progressively around the country from mid-2004 onwards. This is a very ambitious programme, but the needs of our children are urgent. It will need strong support to reach the most vulnerable. Health professional support and education and community communication strategies are core components.

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Eliminating ethnic disparities in health through immunisation: New Zealand's chance to earn global respect

Cameron C Grant, Nikki Turner, Rhys Jones

In September 2008, the HPV vaccine GARDASIL® became the second cancer-preventing vaccine to be included in the New Zealand immunisation schedule. Its inclusion occurs 2 decades after the hepatitis B vaccine (which prevents hepatocellular carcinoma) was introduced in 1985.[1]

Māori have higher incidence and mortality for both hepatocellular carcinoma and cervical cancer than non-Māori.[2] These two diseases contribute to inequalities in mortality between indigenous and non-indigenous populations in New Zealand that are larger than those between American Indians/Alaska Natives and non-Hispanic whites in the United States.[3]

Now that both of these cancers are considered vaccine-preventable, can we be confident that these disparities in health will decrease? Can we even be reassured that existing disparities won't be exacerbated? If one takes a historical perspective then there is little to inspire confidence. Whether examining vaccine-preventable deaths during the decades immediately following the introduction of a national immunisation schedule or vaccine-preventable hospital admissions in more recent times, rates in Māori have been higher than in non-Māori.[4–6]

Lower immunisation coverage is the principal reason for the excess burden of vaccine-preventable communicable disease among Māori. All immunisation coverage surveys performed in New Zealand over the past 20 years using World Health Organization-recommended methods have shown lower immunisation coverage for Māori than for non-Māori.[1,7,8] These studies have examined only those vaccines delivered in the first 2 years of life.

In this issue of the *New Zealand Medical Journal*, Loring and Curtis provide the first substantial piece of evidence about coverage for 11-year-old immunisations in New Zealand.[9] While they are careful to acknowledge the measurement issues which qualify their estimates, their findings indicate that the early childhood ethnic differences in immunisation coverage persist into school-age years.

New Zealand can learn from the experience of other countries that have been successful in eliminating ethnic disparities in immunisation coverage. In the United States, the indigenous to non-indigenous ratios for receipt of the primary series of vaccines—which provide protection against diphtheria, tetanus, pertussis, polio, hepatitis B, measles, mumps, and rubella—range from 0.97 to 1.03. In contrast the indigenous to non-indigenous ratios in New Zealand for these same vaccines range from 0.62 to 0.87.[3] Thus significantly less immunisation coverage for Māori compared to non-Māori, unlike in the United States where no such difference between indigenous and non-indigenous populations exists.

How has the United States achieved this commendable result? Firstly by articulating a priority to *eliminate* ethnic disparities in immunisation coverage.[10] The key interventions that have led to this goal being realised have been the provision of comprehensive health services through the Indian Health Service and more recently through tribal health programmes, home visiting, utilising tribal community centres as well as schools for immunisation delivery, tracking immunisation status, and providing free immunisations.[11]

One year earlier, New Zealand had articulated a similar although more hesitant aim to *reduce* and then to *eliminate* health inequalities that negatively affect Māori.[12] It is disappointing that our statement of purpose was more tentative: there is absolutely no reason why ethnic inequalities in immunisation coverage should be tolerated or allowed to persist. A further source of disappointment—that progress towards equity in New Zealand has been poor compared with the United States despite our statement being made 1 year earlier—reflects this difference in priority and urgency.

What steps have been taken to prevent history repeating itself and to ensure those with the greatest potential for health gain from disease prevention receive immunisations? New Zealand did show significant progress in reducing inequities with the delivery of a meningococcal B mass epidemic programme between 2004 and 2006 given as a three dose schedule to children and youth from 6 weeks to 19 years of age.

Ethnic differences in coverage were not entirely absent but were less marked than in other immunisation programmes. This was most apparent in the school-based programmes, with the three-dose coverage of children aged 5–17 years 4% lower for Māori, —and for children aged 6 weeks to 4 years, 9% lower than for non-Māori.[13] The key contributors to this programme's success were a mass communication campaign, integrated information systems (schools and primary care) and more time and resources to focus on consent forms, precall/recall systems, and outreach follow-up.

So what is required to eliminate disparities in immunisation coverage and hence in vaccine-preventable disease in New Zealand? When we look at the list of things that have allowed the United States to be proud of their efforts we see that many of the components are present in New Zealand. Primary Health Organisations (PHOs) have helped to provide a stronger population focus to primary care. Some of the PHOs have iwi (tribal) affiliations.

We have a near-universal school-based delivery programme (only one district currently does not deliver the 11-year-old programme through schools). We know how to deliver catch up and outreach services. We have the beginnings of an integrated national immunisation information system. We have most of the pieces of the puzzle but they do not currently fit together, nor are they recognisable at times as even being part of the same puzzle.

Loring and Curtis cite the issue of inconsistent denominators as a weakness of their study. These same problems that made their study more difficult to perform and the data collected more difficult to interpret have exactly the same effect on the school-based programme's ability to effectively immunise its population. The Public Health Nurse database did not include all of the children on the school roll. An immunisation service cannot deliver immunisations to every child if it does not know who all of these children are, nor can it be expected to achieve high coverage if there is a lack of clarity about where responsibility for this critical function lies.

Lack of integrated databases between primary care and school-base programmes should eventually resolve. The National Immunisation Register (NIR) which tracks all children's immunisation records was rolled out in a staged fashion based on the birth cohort since 2004/2005. This will become applicable for children entering school from this cohort. However, until then, delivery of state-of-the-art health care and the prevention of death and disease should not be dependent upon a piece of paper reappearing twice from a child's school bag. We can do better than this, as has been shown in the meningococcal B campaign.[13]

There is now good understanding of the need to engage the community more strongly in the issue, of the logistics of running a programme to obtain and maintain high consent form returns in school-based programmes, the need for catch-up and outreach services to find the most vulnerable, and the importance of integrating the primary care and school-based databases through the use of the NIR. A well run school-based programme backed up by a strong national communication strategy and integrated databases should be capable of delivering high immunisation coverage in the New Zealand context.

What we know about current immunisation delivery in New Zealand suggests that money spent purchasing GARDASIL® and other new vaccines will not achieve the potential health benefits on offer because too few people will receive them. Furthermore, as things currently stand, those that need the new vaccines the most and have the greatest potential to benefit will be the least likely to receive them, with an unwarranted share of the benefits accruing to those who already enjoy relatively good health. Consequently, as is the case with most health-sector interventions, the introduction of new vaccines will increase inequalities. This is in direct contravention of the New Zealand Health Strategy.[12]

The potential for cancer to be vaccine-preventable brings a broader perspective to immunisation programmes initially developed to prevent severe communicable disease in the young and to a lesser extent in the elderly. It also brings an increased focus on the poor capacity of the health system to deliver a national schedule of vaccines from infancy though adolescence and into adulthood.

That the elimination of ethnic disparities in immunisation delivery in the United States coincided with their health system achieving higher immunisation coverage across the whole population is no coincidence. Addressing the systemic problems that were responsible for inequalities in coverage led to improved outcomes for all children.

New Zealand can achieve the same but needs to raise the stakes at the individual, community, and national level. We need to:

- Stimulate desire for the product via increased community communication,
- Fund delivery of the product recognising the extra time and resources required to get informed consent within a school context, and
- Integrate (at a national level) the databases to enable every immunisation opportunity to be utilised.

Without all this in place, we risk increasing the disease disparities in our community.

We will never fly to the moon if we build a spaceship with only enough fuel to get halfway there. But the moon won't seem so far away if we get all of our children into the same higher immunisation orbit.

Competing interests: None known.

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Examining immunisation in New Zealand

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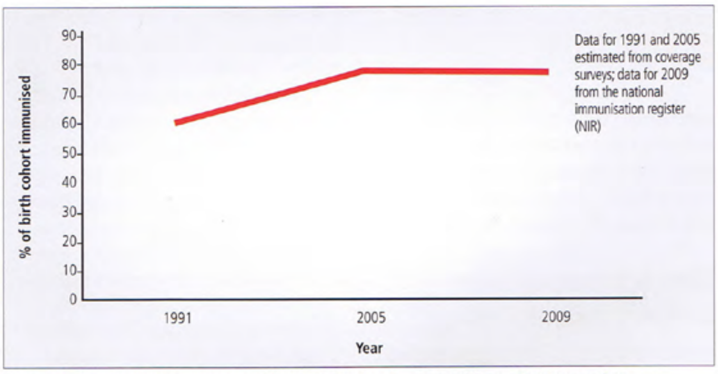
In New Zealand, the first formal schedule for universal immunisation was drawn up in November 1960; this was for the delivery of the diphtheria, tetanus and pertussis vaccine (DTP), which was provided to practitioners free of charge.[1,2] Since September 2008, the schedule includes universal free vaccination against diphtheria, tetanus, pertussis, polio, hepatitis B, *Haemophilus influenzae* type b, pneumococcal disease, measles, mumps, rubella and human papillomavirus (HPV).[2,3] Special groups also receive the influenza, hepatitis B immunoglobulin and Bacillus Calmette-Guérin (BCG) vaccines free.

New Zealand has eliminated polio and controlled diseases such as diphtheria. However, despite a target of 95% of children fully immunised by the age of two, coverage is low and slow compared with other countries (developed and developing). Around 77% of children are fully immunised by their second birthday (see Figure 1) and the figure is lower (62%) for those receiving their primary three doses of vaccine at the due time (measured at one month after the third dose).[4] Several diseases, such as measles and pertussis, remain endemic, resulting in periodic epidemics.

In 2008, the government made improving immunisation coverage one of ten key public health priorities. A change of government reduced these priorities to six, but coverage targets remained on this list.[5]

Decision-making

New vaccines are licensed by Medsafe, New Zealand's medicines and medical devices safety authority. An external advisory group, the Immunisation Technical Forum (ITF), makes recommendations about new vaccines to the Ministry of Health. Recommendations are based on the safety and efficacy of available vaccines, on cost–benefit analysis and, of course, on epidemiology. The immunisation schedule is reviewed by the ITF every two to three years.



Data for 1991 and 2005 estimated from coverage surveys; data for 2009 from the national immunisation register (NIR)

Figure 1. Immunisation coverage in New Zealand – percentage of children fully immunised at the age of two

Final decisions about funding are made by the treasury.

Controlling pertussis has been key in timing the schedule. After the reduction, in 1971, of the pertussis vaccine to two doses (at three and five months of age), several epidemics affected babies under three months. A review of the 1982 epidemic led to the addition, in 1984, of a third dose. Mothers and infants universally attended their GP for a postnatal visit at six weeks of age.[6] It was thought that, if this appointment was used to administer the first dose of vaccine, high coverage would be achieved; this led to the timing of the three primary doses at six weeks, three months and five months.[1]

Delivery

Vaccines are delivered via the general practice for the entire infant immunisation programme, with outreach services in most areas for children who miss out. They may be delivered by medical practitioners, registered midwives, designated prescribers (including registered nurses) or persons allowed to administer medicines by a standing order.

Vaccinator training is recommended (but not compulsory) for all nurses who vaccinate. It includes information about preventable diseases, basic immunology, the cold chain, administration and policy. To vaccinate independently, nurses need to be able to perform emergency techniques, know products and equipment, have clinical interpersonal skills and be able to provide enough information for patients, parents or guardians to make an informed decision. They must then receive authorisation from a medical officer of health.

Most of the scheduled vaccines are delivered by registered nurses in the general practice. The 11-year dose of the new diphtheria, tetanus and acellular pertussis vaccine (DTaP) and the 12-year doses of the HPV vaccine are delivered at school in most parts of New Zealand, but in primary care in most of the South Island. The school-based immunisations are delivered by public health nurses.

Attitudes

Traditionally, New Zealand has had a vociferous anti-immunisation lobby. Around 4–6% of parents actively decline immunisation, but a significantly higher proportion lack confidence in immunisation.[7–9] Data on attitudes are not routinely collected and it is not known if there have recently been quantitative changes. People's concerns are known from media reports[10] and the national immunisation advisory phone line.[11]

This hotline is staffed by registered nurses backed by doctors and scientists, and informs and advises the healthcare professionals and the public on all scheduled vaccines. Healthcare professionals can have their questions answered via the hotline or get advice from one of several doctors specialising in immunisation.

The media have had both a positive and a negative effect on vaccine uptake. Recently, there has been a significant increase in seasonal influenza vaccination after reports on 'swine flu'. Conversely, in 2005, negative reports about the country's tailor-made meningococcal B vaccine resulted in instant cancellations of appointments by concerned parents.[12]

Funding

Delivery is funded by the government on a fee-for-service basis. Practices claim for each immunisation event. The current fee is NZ$18 per event (it was NZ$11 in 1998). There are other subsidies, including practice nurse subsidies and primary healthcare organisations incentives; these vary from region to region.

A recent study found that the actual mean cost, for a general practice, of calling, recalling and immunising children, from birth to the age of five, with the nationally scheduled vaccines, is NZ$25.80 per event, with wide variability across practices.[13]

Barriers

Key factors influencing the immunisation coverage of children under the age of two include attitudes (of the healthcare professionals and of the public), families' income and ethnicity, practice management systems, staff turnover, and the age of enrolment in the general practice.[14]

A significant issue when trying to improve coverage is the lack of reliable data. Until recently, the only estimations came from surveys made in 1992, 1996 and 2005,[15–17] from the number of immunisation fees claimed, from census population data and from practice management systems.[18] In 2004, New Zealand introduced in stages a national immunisation register (NIR), enrolling children from birth and integrated with primary care practice management systems. Today, there are data available for the birth cohort of 2004–05 onwards.

Immunisation events are managed by general practices. These have kept age/sex registers for years and more than 99% now have computerised practice management systems (PMSs). Electronic immunisation precall and recall systems are universally in place. However, a recent study showed difficulties in using these systems, resulting in inaccuracies in the data.[19]

When trying to improve coverage, missed opportunities are also an issue. Missed opportunities occur in all practices and in nearly one-third of all visits. Children who have missed opportunity visits have up to a tenfold increased risk of not being immunised on time.[20]

There are several other barriers to improving coverage, including:

- The financial cost for practices – the level of subsidy is much lower than the actual cost of a standard immunisation
- The knowledge and attitudes of both parents and professionals – a confident professional can have a significant influence on parents; however, both staff and parents can also be influenced by scare stories and myths
- Social deprivation and having a Maori or Pacific ethnic background (both barriers to accessing services).

The following factors are likely to have significant positive effects on coverage:

- Early enrolment of children creating earlier engagement with families
- A well trained and stable general practice workforce
- An effective practice management alert system
- Following up missed opportunities at every visit.

Recent progress

Despite an overall low coverage, there have been improvements over the past few years. Some practices achieve a coverage of over 90% of two-year-olds enrolled with them.[21] Factors associated with higher coverage in individual practices are a strong commitment to immunisation,[21] a stable workforce and the early enrolment of infants.[13,19]

Key points

- In New Zealand, immunisation is delivered mainly by nurses in the general practice.
- Immunisation coverage has been low for many years, and it is still too low to control diseases such as pertussis.
- Key factors to improve coverage include better funding, better use of general practice management systems, fewer missed opportunities, closer relationships with the practice population, and better education of healthcare professionals and families.

There has been some narrowing of the equity gap between the different ethnic groups, although vaccination rates remain considerably lower for Maori people. Rates for Pacific people used to be significantly lower than the national average, but have improved considerably in recent years; however, Pacific people continue to show higher rates of delayed vaccination. Rates of vaccination continue to be lower for children from highly deprived families ■

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Editorial

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The challenge of improving immunization coverage: the New Zealand example

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> "…progress since 2007 has been very promising … what are the reasons for this progress and what have we learned along the way?"

Childhood immunization is one of the most cost-effective activities in healthcare. Every country in the world has a national immunization program and these programs have had a significant impact on childhood diseases [1]. However, despite these successes, many countries continue to have challenges with poor immunization coverage rates, and associated challenges with vaccine-preventable diseases, such as measles and pertussis, that could be eliminated or better controlled by achieving higher immunization coverage [2].

Immunization coverage in New Zealand

Traditionally, New Zealand (NZ) has had mediocre immunization coverage, with significant disparities for indigenous children (Maori) and children of Pacific Island ethnicity [3]. A national coverage survey in 1991 demonstrated that less than 60% of children were fully immunized by 2 years of age, including only 42% of Maori children and 45% of Pacific children [3]. Gains, albeit slow, were made over the following years, so that by 2005 77% of children were fully immunized by 2 years of age, including 69% of Maori and 85% of Pacific children [4].

In 2005, New Zealand implemented a National Immunisation Register (NIR) where, at birth, all children were entered onto the register using their unique national health number. Immunization services for the under 5 years of age childhood program in NZ are delivered almost entirely via general practice (primary care) with back-up outreach services. Every immunization event for children born since 1995 is entered onto the NIR via direct download from the electronic practice management system. Data from this register have been available since June 2007, with rates at the time of 75% of the target population fully immunized at 2 years of age. Rates had reached 80% by early 2009, and 85% by mid-2010. By June 2011, rates of immunization for those at 2 years of age were over 90% [101]. Furthermore, the equity gap has been closing, with Maori rates in June 2011 of 88% and Pacific rates of 94%. In 2007, there was a 9.5% coverage difference between the children from the lowest socioeconomic decile and those from the highest decile, which by June 2011 had closed to a 4% gap [101].

> "By June 2011, rates of immunization for those at 2 years of age were over 90%."

NZ's national targets are 95% coverage of the target population at the age of 2 years and to have no equity gaps [5]. The progress since 2007 has been very promising. This poses the questions: what are the reasons for this progress and what have we learned along the way?

Strategies to improve coverage

How much has government policy and local district health board attention made a difference? Recognizing there were mediocre immunization rates, the NZ Ministry of Health developed strategic goals for

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improving immunization coverage [6]. A core component of this strategy was to implement an NIR as a tool for supporting delivery, reporting and monitoring. This was slow in coming, but finally propelled along by NZ rolling out a national vaccination program in response to a meningococcal B epidemic in 2005. Without the imperative of the epidemic, the register would probably have taken much longer to arrive. The NIR appears to have been a core component in the drivers to improvement as progress can now be monitored and real-time feedback to various service levels is now possible. In 2008, the government made improving immunization coverage one of ten key public health priorities. A change of government subsequently reduced these to six priorities, but a childhood immunization coverage target remained on the list [7]. A strong driver for action from this strategy has been the regular public feedback of progress: this included regular media publications comparing the achievements of all the District Health Boards.

Recognizing that there was more attention as well as timely monitoring and feedback of progress, what else has NZ done to improve their record?

Based on international evidence, there are three major areas that consistently create significant barriers to obtaining and maintaining high immunization coverage: issues related to poverty, system and provider practices, and family and child characteristics [8].

At the provider level, research in NZ identified a range of barriers at the service delivery level (primary care) to obtaining high coverage. The most important of these were structural and organizational aspects. The most significant factors were the age of enrollment of the infant (the earlier the better), the type of practice management system used and the presence of a stable practice with low staff turnover [9]. Second was the functioning of the healthcare team: having well-supported staff with dedicated time for immunization service delivery, and with positive, engaged relationships with the children and their families [10]. Third was the healthcare professionals themselves feeling both confident and knowledgeable [11]. While there are gaps identified in their overall knowledge that are important to address, it is likely that the confidence to communicate effectively with parents is the more important factor [12].

> “...there are three major areas that consistently create significant barriers to obtaining and maintaining high immunization coverage: issues related to poverty, system and provider practices, and family and child characteristics.”

A confident, engaged healthcare professional working in a supportive stable team and given enough time and resources can utilize effective systems to maximize effective enrollment, precall and recall, and take every opportunity to reduce missed opportunities to immunize when the children are in the practice [13]. Furthermore, recognizing that there are many competing healthcare priorities in primary care, immunization as an issue needs champions within the practice to keep the focus and ongoing prioritization.

It has long been recognized that there are challenges in obtaining high immunization coverage for children from more vulnerable groups – in particular lower socioeconomic backgrounds and ethnic groups that have traditionally had poorer health outcomes. NZ can now show that a well-supported and effective primary care service delivery can effectively deliver to these high-needs groups and overcome equity gaps in their enrolled population. If a child is enrolled early with a provider with good engagement and effective systems, immunization is highly likely to occur and, of equal importance, occur in a timely fashion [14]. However, if enrollment does not occur at birth or soon after, the child is much less likely to be immunized on time [14].

> “...the most efficacious vaccine in the world will have limited effect in the absence of an equally effective delivery mechanism to the population.”

Outreach services in NZ deliver immunization to children identified at the practice level. Numerically, small numbers of children in NZ receive immunizations via the outreach services, and these services are expensive; however, these children are likely to be in the higher-needs group and hence there is an important ethical reason to support services to access them. Second, as immunization coverage gets higher in a community, these children become a significant percentage of those still missing out.

Receiving the first dose of the vaccination schedule on time is one of the strongest and most consistent predictors of subsequent complete immunization [15]. Early parental decision-making processes in the antenatal period with good health provider engagement need to occur to support timely immunization delivery. The majority of parents make their decisions antenatally [16] and it is clear that good decision-making tools support confident, positive parental decisions [17], whereas receiving misinformation in this period negatively impacts on parental decision-making [10,18].

There are also broader environmental influences that impact on community, parental and health professional knowledge, and probably more importantly, on their confidence in the safety and effectiveness of the program. NZ has always had an active anti-immunization sentiment presented in the traditional and social media, which has lessened over the past few years [19]. Learning how to more effectively communicate science at many levels and to many different audiences is important. Working closely with the media including being available and accessible, and recognizing that the drivers for the media needs are, at times, different from public health programs [19] are all part of building an environment that is confident in the decisions behind its immunization program.

Conclusion

In summary, immunization programs require good coverage rates and timeliness of delivery to be effective: the most efficacious vaccine in the world will have limited effect in the absence of an equally effective delivery mechanism to the population. NZ came from a background of medioce immunization coverage 4 years ago to achieving reasonably high immunization coverage rates, better timeliness of delivery and closing of the traditional equity gaps.

Prioritizing immunization at the national level and district level with clear policy and having the right tools to measure coverage, public reporting and feedback loops appear to underpin progress. The antenatal period is vital for the engagement and support of parents in immunization decision-making. Systems matter – systems at the district and local levels that focus, monitor and feedback – provider systems that effectively enrol infants at birth, enable engagement, precall, audit and create prioritization of immunization at all visits. Providers matter – a good working environment, support, knowledge, confidence and encouraging champions. An effective health system goes hand in hand with wider health system support, creating greater community confidence in the program using social networks and the broader mass media. While there are often resourcing issues, NZ has to date increased coverage with relatively limited resourcing, without the use of incentivization approaches for parents or increasing incentives to providers, nor with any large media campaigns. Time will tell whether extra measures such as these are necessary to reach the goal of 95% coverage.

Recommendations

To make more effective use of childhood vaccines, there needs to be greater country and international attention towards achieving better immunization coverage and timeliness of delivery for all children. While service delivery is often locality specific, there are many commonalities. The NZ example demonstrates that focusing on the more mundane issues – data collection, feedback, enrollment and early engagement of infants, and attention to systems and providers – produces good results.

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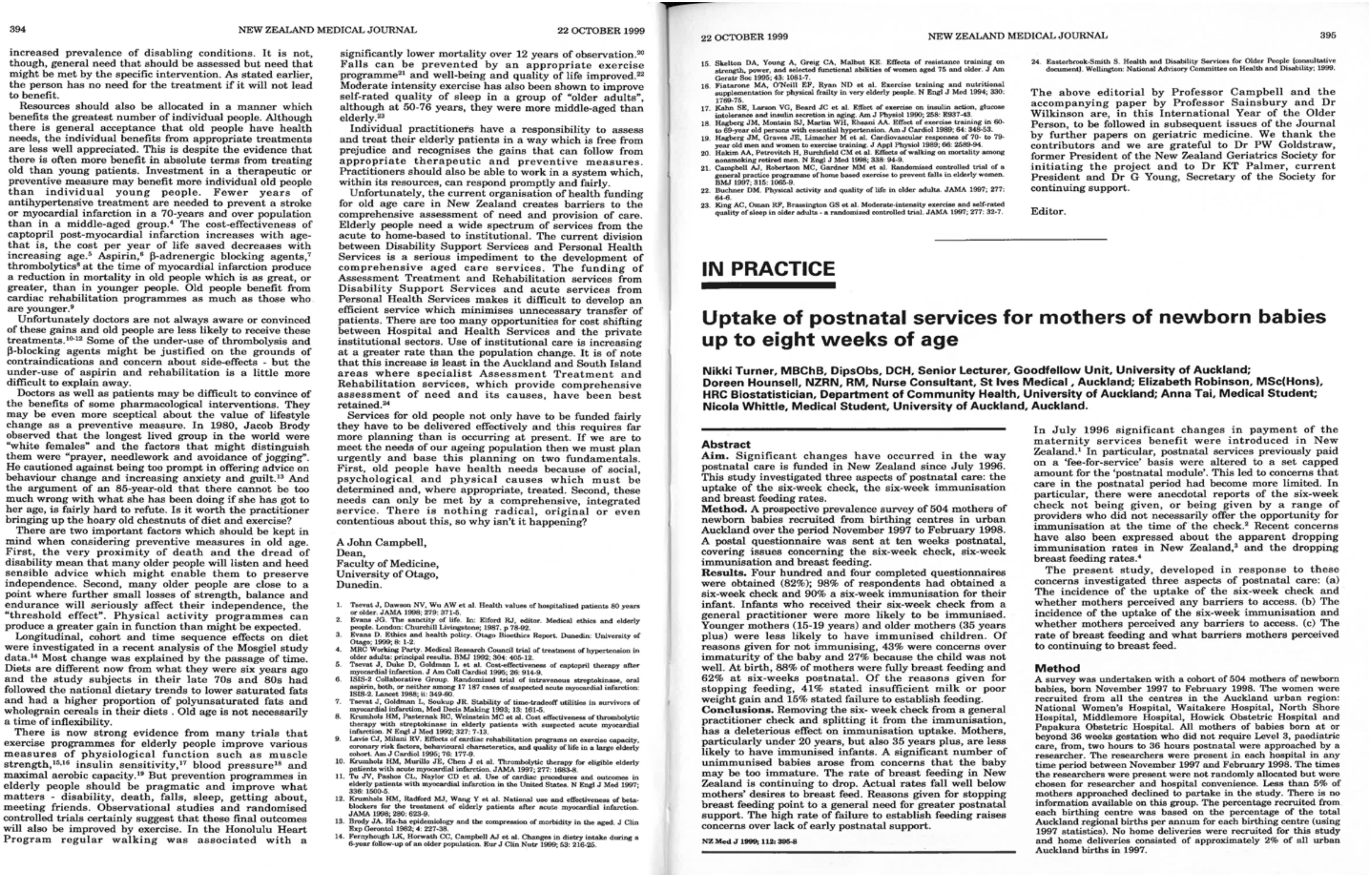

increased prevalence of disabling conditions. It is not, though, general need that should be assessed but need that might be met by the specific intervention. As stated earlier, the person has no need for the treatment if it will not lead to benefit.

Resources should also be allocated in a manner which benefits the greatest number of individual people. Although there is general acceptance that old people have health needs, the individual benefits from appropriate treatments are less well appreciated. This is despite the evidence that there is often more benefit in absolute terms from treating old than young patients. Investment in a therapeutic or preventive measure may benefit more individual old people than individual young people. Fewer years of antihypertensive treatment are needed to prevent a stroke or myocardial infarction in a 70-years and over population than in a middle-aged group.[4] The cost-effectiveness of captopril post-myocardial infarction increases with age-that is, the cost per year of life saved decreases with increasing age.[5] Aspirin,[6] β-adrenergic blocking agents,[7] thrombolytics[8] at the time of myocardial infarction produce a reduction in mortality in old people which is as great, or greater, than in younger people. Old people benefit from cardiac rehabilitation programmes as much as those who are younger.[9]

Unfortunately doctors are not always aware or convinced of these gains and old people are less likely to receive these treatments.[10-12] Some of the under-use of thrombolysis and β-blocking agents might be justified on the grounds of contraindications and concern about side-effects - but the under-use of aspirin and rehabilitation is a little more difficult to explain away.

Doctors as well as patients may be difficult to convince of the benefits of some pharmacological interventions. They may be even more sceptical about the value of lifestyle change as a preventive measure. In 1980, Jacob Brody observed that the longest lived group in the world were "white females" and the factors that might distinguish them were "prayer, needlework and avoidance of jogging". He cautioned against being too prompt in offering advice on behaviour change and increasing anxiety and guilt.[13] And the argument of an 85-year-old that there cannot be too much wrong with what she has been doing if she has got to her age, is fairly hard to refute. Is it worth the practitioner bringing up the hoary old chestnuts of diet and exercise?

There are two important factors which should be kept in mind when considering preventive measures in old age. First, the very proximity of death and the dread of disability mean that many older people will listen and heed sensible advice which might enable them to preserve independence. Second, many older people are close to a point where further small losses of strength, balance and endurance will seriously affect their independence, the "threshold effect". Physical activity programmes can produce a greater gain in function than might be expected.

Longitudinal, cohort and time sequence effects on diet were investigated in a recent analysis of the Mosgiel study data.[14] Most change was explained by the passage of time. Diets are different now from what they were six years ago and the study subjects in their late 70s and 80s had followed the national dietary trends to lower saturated fats and had a higher proportion of polyunsaturated fats and wholegrain cereals in their diets . Old age is not necessarily a time of inflexibility.

There is now strong evidence from many trials that exercise programmes for elderly people improve various measures of physiological function such as muscle strength,[15,16] insulin sensitivity,[17] blood pressure[18] and maximal aerobic capacity.[19] But prevention programmes in elderly people should be pragmatic and improve what matters - disability, death, falls, sleep, getting about, meeting friends. Observational studies and randomised controlled trials certainly suggest that these final outcomes will also be improved by exercise. In the Honolulu Heart Program regular walking was associated with a significantly lower mortality over 12 years of observation.[20] Falls can be prevented by an appropriate exercise programme[21] and well-being and quality of life improved.[22] Moderate intensity exercise has also been shown to improve self-rated quality of sleep in a group of "older adults", although at 50-76 years, they were more middle-aged than elderly.[23]

Individual practitioners have a responsibility to assess and treat their elderly patients in a way which is free from prejudice and recognises the gains that can follow from appropriate therapeutic and preventive measures. Practitioners should also be able to work in a system which, within its resources, can respond promptly and fairly.

Unfortunately, the current organisation of health funding for old age care in New Zealand creates barriers to the comprehensive assessment of need and provision of care. Elderly people need a wide spectrum of services from the acute to home-based to institutional. The current division between Disability Support Services and Personal Health Services is a serious impediment to the development of comprehensive aged care services. The funding of Assessment Treatment and Rehabilitation services from Disability Support Services and acute services from Personal Health Services makes it difficult to develop an efficient service which minimises unnecessary transfer of patients. There are too many opportunities for cost shifting between Hospital and Health Services and the private institutional sectors. Use of institutional care is increasing at a greater rate than the population change. It is of note that this increase is least in the Auckland and South Island areas where specialist Assessment Treatment and Rehabilitation services, which provide comprehensive assessment of need and its causes, have been best retained.[24]

Services for old people not only have to be funded fairly they have to be delivered effectively and this requires far more planning than is occurring at present. If we are to meet the needs of our ageing population then we must plan urgently and base this planning on two fundamentals. First, old people have health needs because of social, psychological and physical causes which must be determined and, where appropriate, treated. Second, these needs can only be met by a comprehensive, integrated service. There is nothing radical, original or even contentious about this, so why isn't it happening?

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The above editorial by Professor Campbell and the accompanying paper by Professor Sainsbury and Dr Wilkinson are, in this International Year of the Older Person, to be followed in subsequent issues of the Journal by further papers on geriatric medicine. We thank the contributors and we are grateful to Dr PW Goldstraw, former President of the New Zealand Geriatrics Society for initiating the project and to Dr KT Palmer, current President and Dr G Young, Secretary of the Society for continuing support.

Editor.

IN PRACTICE

Uptake of postnatal services for mothers of newborn babies up to eight weeks of age

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Abstract

Aim. Significant changes have occurred in the way postnatal care is funded in New Zealand since July 1996. This study investigated three aspects of postnatal care: the uptake of the six-week check, the six-week immunisation and breast feeding rates.

Method. A prospective prevalence survey of 504 mothers of newborn babies recruited from birthing centres in urban Auckland over the period November 1997 to February 1998. A postal questionnaire was sent at ten weeks postnatal, covering issues concerning the six-week check, six-week immunisation and breast feeding.

Results. Four hundred and four completed questionnaires were obtained (82%); 98% of respondents had obtained a six-week check and 90% a six-week immunisation for their infant. Infants who received their six-week check from a general practitioner were more likely to be immunised. Younger mothers (15-19 years) and older mothers (35 years plus) were less likely to have immunised children. Of reasons given for not immunising, 43% were concerns over immaturity of the baby and 27% because the child was not well. At birth, 88% of mothers were fully breast feeding and 62% at six-weeks postnatal. Of the reasons given for stopping feeding, 41% stated insufficient milk or poor weight gain and 15% stated failure to establish feeding.

Conclusions. Removing the six- week check from a general practitioner check and splitting it from the immunisation, has a deleterious effect on immunisation uptake. Mothers, particularly under 20 years, but also 35 years plus, are less likely to have immunised infants. A significant number of unimmunised babies arose from concerns that the baby may be too immature. The rate of breast feeding in New Zealand is continuing to drop. Actual rates fall well below mothers' desires to breast feed. Reasons given for stopping breast feeding point to a general need for greater postnatal support. The high rate of failure to establish feeding raises concerns over lack of early postnatal support.

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In July 1996 significant changes in payment of the maternity services benefit were introduced in New Zealand.[1] In particular, postnatal services previously paid on a 'fee-for-service' basis were altered to a set capped amount for the 'postnatal module'. This led to concerns that care in the postnatal period had become more limited. In particular, there were anecdotal reports of the six-week check not being given, or being given by a range of providers who did not necessarily offer the opportunity for immunisation at the time of the check.[2] Recent concerns have also been expressed about the apparent dropping immunisation rates in New Zealand,[3] and the dropping breast feeding rates.[4]

The present study, developed in response to these concerns investigated three aspects of postnatal care: (a) The incidence of the uptake of the six-week check and whether mothers perceived any barriers to access. (b) The incidence of the uptake of the six-week immunisation and whether mothers perceived any barriers to access. (c) The rate of breast feeding and what barriers mothers perceived to continuing to breast feed.

Method

A survey was undertaken with a cohort of 504 mothers of newborn babies, born November 1997 to February 1998. The women were recruited from all the centres in the Auckland urban region: National Women's Hospital, Waitakere Hospital, North Shore Hospital, Middlemore Hospital, Howick Obstetric Hospital and Papakura Obstetric Hospital. All mothers of babies born at or beyond 36 weeks gestation who did not require Level 3, paediatric care, from, two hours to 36 hours postnatal were approached by a researcher. The researchers were present in each hospital in any time period between November 1997 and February 1998. The times the researchers were present were not randomly allocated but were chosen for researcher and hospital convenience. Less than 5% of mothers approached declined to partake in the study. There is no information available on this group. The percentage recruited from each birthing centre was based on the percentage of the total Auckland regional births per annum for each birthing centre (using 1997 statistics). No home deliveries were recruited for this study and home deliveries consisted of approximately 2% of all urban Auckland births in 1997.

Participants were given an information sheet in an appropriate language, and a consent form to sign. Questionnaires were posted out at ten weeks postnatal. Translated questionnaires were available in Chinese characters and four Pacific Islands languages. Those who failed to return questionnaires after four weeks were contacted by telephone, or if telephone contact was not possible, a further questionnaire was sent.

All data were entered on a Microsoft Excel spreadsheet. The six-week postnatal rate, breast feeding rates and six-week immunisation rates are presented with 95% confidence intervals. These results are all based on mothers' recall, and were not cross-checked through health records due to limited resources. The mothers' reasons given for failure to obtain a six-week check, non-immunisation and reason for changing from breast feeding were coded and quantified into categories and are presented as percentages.

A multivariate analysis was undertaken using the following explanatory variables: age groups, ethnicity (Maori, Pacific Islander, European, Asian and Other), mother of a first child or not, lead maternity caregiver (independent midwife, general practitioner, hospital specialist and team/hospital midwife, private specialist), health professional delivering the six-week check (solely independent midwife, solely public hospital staff, solely private specialist, or general practitioner either solely or in conjunction with other health professional). Logistic regression was used to investigate the relationship between these factors and the outcomes of immunisation and breast feeding at six weeks postnatal.

Results

There were 504 questionnaires sent out. Of these, 17 were excluded due to having the wrong address, address unknown or unclear, consent not signed and declined to participate. Of questionnaires sent out, 401 were completed, a response rate of 82%.

Background information on participants in the study is shown in Table 1.

Table 1.Background information on participants.

	Number	%	
Ethnicity			
European	227	57.0	*(46.4)
Maori	49	12.3	(20.1)
Samoan	33	8.3	(10.2)
Asian	27	6.8	(6.7)
Cook Island	10	2.5	(3)
Tongan	7	1.8	(5.6)
Niuean	5	1.3	(1.1)
Other	40	10.0	(10)
Unknown	2	-	-
Age Group			
15-19	8	2.1	
20-24	61	15.7	
25-29	107	27.4	
30-34	130	33.3	
35-39	68	17.4	
40+	16	4.1	
Unknown	10	-	
Number of other living children			
None	176	44.7	
One	133	33.7	
Two	44	11.2	
Three	25	6.3	
Four or more	16	4.1	
Unknown	10	-	

*Data in brackets are the regional ethnicity birth data for November 1997 - February 1998, from the Department of Statistics.

The lead maternity caregiver was identified by asking "who was the main person looking after you in your pregnancy?" A total of 122 (31%) stated an independent midwife, 109 (28%) a general practitioner, 71(18%) a hospital midwife, 70(18%) a private specialist and 20 (5%) a hospital specialist.

The six-week check. Mothers were asked if their baby had received a 'six-week baby check". Three hundred and eight-eight (97.7%, 95% confidence interval 95.7% - 99%) stated they had and nine had not. The small group who did not receive a check gave no clear reasons as to why.

The six-week immunisation. Mothers were then asked if their baby had received its first "immunisation or injection by eight weeks of age". A total of 359 (90.2%, 95% confidence interval, 86.8% - 92.9%) stated they had obtained the immunisation.

Those who had not received an immunisation for their baby (n=39) were asked to give their reasons why. All responded, with six giving two reasons. Responses were quantified into clear broad categories (Table 2).

Table 2. Reasons given for not obtaining immunisation.

	Number	%
Unwell child	12	24.5
Personal family choice	10	20.4
Choice to delay until the child is older	21	42.9
Unwell mother	2	4.1
Access issues	2	4.1
Concerns re vaccines side-effects	1	2.0
Other	1	2.0
Total responses	49	

Logistic regression was used to investigate the effect of maternal age, ethnicity of the mother, lead maternity caregiver, person giving the six-week check and family order (first born or not) on whether or not the child was immunised. The age of the mother (p=0.02) and the person giving the six-week check (p=0.02) (Table 3) were found to affect whether the child was immunised. The type of lead maternity caregiver was not found to have any effect on the outcome. Babies seen by general practitioners at six-week check had a higher rate of immunisation than those seen solely by midwives or other health professionals.

Table 3. The person who gave the six-week check and immunisation of babies.

Person who gave the six-week check	Independent midwife	Private specialist	Hospital specialist or midwife	General practitioner
Not immunised	14 (24.1%)	6 (11.5%)	3 (16.7%)	15 (5.7%)
immunised	44 (75.9%)	46 (88.5%)	15 (83.3%)	247 (95.2%)

Table 4. The age of the mother and immunisation of babies.

Age (years)	15-19	20-24	24-29	30-34	35-39	40+
Not immunised	3 (37.5%)	2 (3.3%)	7 (6.5%)	13 (10%)	11 (16.4%)	2 (12.5%)
Immunised	5 (62.5%)	59 (96.7%)	100 (93.5%)	117 (90%)	56 (83.6%)	14 (87.5%)

With respect to maternal age the 20-24 year olds had the highest rate of immunisation of babies and those aged 15-19 the lowest, although the numbers are small. Table 4 gives an indication of this effect although it does not control for the other variables in the model.

Breast feeding. Mothers were asked what type of feeding they had decided to do when they were pregnant, what type of feeding they started when the baby was born, the type of feeding when the baby was six weeks of age and, if they changed from breast to bottle feeding when this occurred. They were then given an open-ended question asking what were the main reasons they stopped breast feeding.

The desire to breast feed was matched by the number of mothers fully breast feeding at birth. In total, 318 (80%) of women had the desire to breast feed while pregnant, 35 (8.8%) wished to partially bottle feed and 27 (6.8%) were not sure. At birth, 352 (88.4%) initiated breast feeding.

However, by six weeks of age the number of mothers stating they were "fully breast feeding" dropped to 250 (63.5%), with 88 (22.3%) partially breast/bottle feeding and 56 (14.2%) bottle feeding.

When asked how old the baby was when they stopped breast feeding, a total of 124 responded. Of these 18 (14.5%) stopped in less than one week, 14 (11.3%) in 1-2 weeks, 20 (16.1%) in 2-4 weeks, 12 (9.7%) at 4-6 weeks and 60 (48.4%) after six weeks. A total of 144 mothers gave reasons for stopping breast feeding which are grouped into categories in Table 5. Of those responding, 34 offered more than one reason.

Table 5. Reason for stopping breast feeding.

	Number	%
Insufficient milk or poor weight gain	59	41
Not established/latching on	21	15
Breast infection/pain	18	12.5
Problem/pain in nipples	16	11
Return to work/study	16	11
Too tired	16	11
Convenience	11	8
Stressed	9	6
Personal choice	9	6
Unsettled baby	4	3
Unwell baby	4	3
Unwell mother	4	3
Lack of support	1	<1

An ordinal logistic regression was used to investigate the effect of the age of the mother, ethnicity, lead maternity caregiver and birth order on type of feeding at six weeks. Only the age of the mother was found to have an effect on this outcome ($p=0.04$). Although the pattern is not entirely clear there seemed to be more fully bottle fed babies with younger mothers (15-24 years) and older mothers (40+ years) (Table 6).

Table 6. Breast feeding at six weeks.

Age (years)	15-19	20-24	25-29	30-34	35-39	40+
Fully breastfed	4 (50%)	28 (45.9%)	67 (65.6%)	91 (71.2%)	47 (71.2%)	8 (53.3%)
Partially breastfed	3 (37.5%)	21 (34.4%)	24 (34.4%)	23 (18%)	10 (15.2%)	4 (26.7%)
Fully bottle fed	1 (12.5%)	12 (19.7%)	16 (15%)	14 (10.9%)	9 (13.6%)	3 (20%)

Discussion

This was a prospective prevalence survey based on the mothers' self-report. Although the response rate (82%) was high, limitations include lack of information about the other 18% and those who declined to participate. The lower than expected rate of returns from Maori and Tongan mothers compared to census data (Table 1) is also a potential source of bias.

The excellent uptake rate of the six-week check (97.7%) is similar to that noted by Ford et al in 1994,[5] where in their nation-wide study group of 1819 children, 94.8% had obtained a six-week check.

Analyses showed (Table 3) that a child who had a six-week check by a general practitioner was significantly more likely to be immunised than a child who had a six-week check from another health provider. This could be interpreted as either that children attending a general practitioner have more opportunity for immunisation, or perhaps mothers attending someone other than their general practitioner may be less inclined to get their children immunised. Either way this highlights the concern that splitting delivery of the six-week check from delivery of the six-week immunisation appears to have a negative impact on the rate of immunisation uptake. It lends support to the need to reinstate the six-week check back with the general practice that is to be involved with the ongoing immunisation programme. The alteration to the payment of the infant six-week check that occurred in March 1998[6] offers some improvement.

Significantly, only 90% of children were immunised by ten weeks. With 18% of questionnaires unreturned and lower representation for Maori and Pacific Islanders who are known to have markedly lower immunisation rates,[7] this is likely to be an over-representation of the current immunisation status in the Auckland region. The 1996 coverage survey[7] estimated 89.2% (86.9-91.5) of children in the North Health region at the age of two years had obtained a six-week immunisation. This survey suggests that, at best, there has been no improvement in immunisation rates since 1996. A 1998 article[3] goes further and reports that immunisation rates appear to be declining. In comparison, a 1997 study on a birth cohort in Christchurch[8] reported six-week immunisation rates to be 93.9%, suggesting there may be considerable regional differences in immunisation rates.

The higher likelihood of younger mothers (Table 4) having unimmunised children is not a new finding with access issues very prominent in this group.[9] Older mothers (35+) also show a trend towards lower immunisation rates, though the numbers were very small. This trend is worth exploring further. We propose that this older age group could be one more likely to be influenced by anti-immunisation sentiment.

The mothers' reasons for choosing not to immunise highlighted some clear issues. Just under 50% (n=21) of all the mothers who responded stated that they chose to delay immunisation until the child was older. This appears to be a more commonly held belief than has previously been seen in any New Zealand literature[7,10,11] and needs urgent addressing, with education both of health professionals and parents. Two concerns arise out of a delayed start to the immunisation schedule. Firstly, it has clearly been shown both in international[12,13] and in New Zealand literature[7,14] that children who have a delayed start to their immunisation programme are significantly less likely to complete the schedule. Secondly, with delayed start to the immunisation schedule an increased number of infants are at risk of pertussis. The next pertussis epidemic may arrive any time from the year 2000 on.[15]

Of further concern is the finding that for babies not immunised, one quarter of mothers stated it was due to the child being unwell. International experience[16,17] indicates that the biggest missed opportunity for immunisation is due to false contraindications to vaccination such as minor illnesses. Increasing educational emphasis for immunisation providers regarding true contraindications, and the importance of on-time immunisation, could reduce such incorrect views.

Rates of breast feeding in New Zealand have historically waxed and waned, with a nadir in the late 1960s when rates dropped to around 41%[18] after which there was a rapid increase in breast feeding rates through till 1991, a period when rates remained relatively unchanged at around 85-90% for the first three weeks of age.[18] However, over the last four years there has been a significant fall with rates noted in 1997 of around 64% 'fully' breast fed at six weeks.[4] This is well below the recommended ideal breast feeding rates of around 90% exclusive breast feeding for four to six months.[19,20] It also falls short of the Public Health Commission target for 75% of infants to be fully breastfed at three months of age by the year 2000.[21] Concerns have been expressed about the impact the change in maternity services and funding has had on this target.[22]

This study found slightly lower rates for full breast feeding at six-weeks (62%) than in 1997 data,[4] (64%) and clearly lower rates than those quoted in 1994 (75% fully breast feeding at six weeks[4]). The postnatal funding changes have been introduced since July 1996 and breast feeding rates have been declining through this period. While this study cannot make a direct link to the funding

changes the downwards trend is clear and needs further explaining. Furthermore, the present study highlights the gap between the active decision to breast feed and the actual feeding rates. The desire to breast feed is comparable to a New Zealand Plunket survey published in 1993.[23] Hence the dropping breast feeding rates cannot be ascribed to a change in maternal desire to feed. The trend noted in this study of an increased likelihood for younger mothers to have a lower rate of breast feeding has been noted elsewhere.[24] A trend was also noted here for older mothers (40 years plus) to have a lower rate. However, the number in this group is small, so cannot be overinterpreted.

While 88% of women started feeding at birth, one quarter of these had stopped by the time the infant was six weeks of age. Maternal reasons for stopping fell into clear groups. The most significant finding was that 41% of women no longer breast feeding stated that insufficient milk or poor weight gain contributed to their stopping feeding. While this statement from mothers does not clarify how much contribution is from maternal attitudes[25] and how much is from postnatal support, it does highlight a significant area for postnatal education. Of note is that 15% of mothers' replies contained a statement of reasons for stopping feeding which related to failure to establish or latch on. This seems particularly pertinent to concerns expressed over lack of support in the early postnatal period, including policy issues such as early discharge.[22] Findings from the Plunket National Child Health study[23] showed that women discharged early were less likely to initiate breast feeding. This study showing approximately one in seven of all women who try, fail to establish feeding, supports this concern.

A further 21% of reasons for stopping breast feeding included tiredness, stress and lack of support - all potentially remediable with increased postnatal support. Issues that are potentially reversible with increased postnatal support would fall in the categories of unsettled babies, insufficient milk, breast infections, nipple problems/infections, not established, tiredness, stress and lack of support. These amounted to three-quarters of all answers, indicating strongly that the mothers themselves are stating issues particularly related to support and education.

This study therefore highlights two particular areas of concern. 1. Splitting the six-week check from the six-week immunisation, which came about mainly as a result of the 1996 changes in the maternity service benefit, does not appear to have been a sensible strategy. Immunisation rates, are lower for mothers getting their six-week check other than with the general practitioner who delivers the immunisation. Immunisation rates remain low with no sign of improvement and a significant percentage of parents are choosing to delay starting the immunisation programme.

2. The dropping breast-feeding rates, despite mothers' desires to breast feed, point to a general need for greater postnatal support. Concerns over lack of early postnatal support in the present New Zealand system appear to also be evident in the high rate of failure to establish feeding. Urgent further work needs to be done in the area of post natal health services support.

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BOOK REVIEW

Plagues on our doorstep. The threat of infectious disease in New Zealand

By Jason Eberhart-Phillips. Published by Tandem Press. ISBN: 1877178 52 7. Price $24.95.

Dr Eberhart-Phillips has written a highly readable account of the threat of infectious diseases in New Zealand. This is the latest in a series of books examining the re-emergence of infectious diseases as a serious threat to health worldwide. These works have warned of potential dangers after a long period of complacency in which the bugs were assumed to have been beaten. This book is especially welcome because it has a New Zealand focus and takes a more moderate tone than some of its more sensational predecessors.

The book is organised into chapters each devoted to a mechanism which upsets the balance between man and the microbial world. These include travel and commerce, demographics, changing land use and technology as well as having chapters on microbial adaptations and antimicrobial resistance. The focus is primarily epidemiological but is laced with interesting historical anecdotes which makes for fascinating reading. It can be easily penetrated by interested laymen as well as medical professionals. It will make a very useful and relatively painless introduction to this important topic for medical students and nurses.

This book is also timely as it describes a problem of increasing antimicrobial resistance among important pathogens in New Zealand and publicises the poor immunisation coverage rates in this country. New Zealand is now regarded as an exporter of measles to the South Pacific regions as these nations have more effective immunisation programmes than New Zealand. It would be worth presenting a copy to our politicians as well as encouraging it to be read by the population at large.

ST Chambers
Christchurch

7. Petousis-Harris H, Turner N, Kerse N. New Zealand mothers' knowledge of and attitudes towards immunisation. Papers 7: NZ Fam Phys 2002;29(4):240-246.

Original Scientific Paper

New Zealand mothers' knowledge of and attitudes towards immunisation

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ABSTRACT

Aim

To identify parental knowledge and concerns about immunisation.

Method

A random walk methodology was used to identify households containing mothers of young children willing to participate in the survey. This sample pool was supplemented from a database of similar households.

Results

There were 500 participants from national urban areas. It was found that one in eight of all mothers interviewed were not convinced that vaccination prevents disease, or that measles can be a severe disease. Furthermore there is a high level of misconception about the cause, transmission and prevention of disease. Other significant findings were that immunisation is not always routinely discussed by Lead Maternity Caregivers (LMCs) especially withholder mothers.

Implications/Conclusion

The results of this survey indicate that the low level of confidence among urban New Zealand mothers over vaccination may be in itself sufficient to prevent New Zealand's target vaccine uptake rate of 95% from being achieved.

Key Words

Immunisation, attitudes

(NZFP 2002; 29: 240–246)

Background

Since 1990 considerable declines in morbidity internationally have been reported for the nine vaccine-preventable diseases for which vaccination of children has been recommended. Morbidity associated with smallpox and polio caused by wild-type viruses has declined by 100% and nearly 100% for each of the other seven diseases: Pertussis, Diphtheria, Haemophilius Influenzae B, Measles, Mumps, Rubella and Hepatitis B.[1] The paradox is that the diseases no longer serve as a reminder of the need for immunisation and in their relative absence parents are becoming increasingly focused on the adverse reactions sometimes associated with the vaccines.[2-6] Immunisation may becoming undervalued by virtue of its own success.

For immunisation programmes to be fully effective they must maintain uniform coverage levels of over 85–95%. In New Zealand the 1992 national coverage survey found less than 60% of children were fully immunised by the age of two years.[7] A repeat coverage survey in 1996 in the Northern region found a small improvement, with an overall coverage rate of 63% at the age of two years.[8] There have been no clear improvements since that time[9] and controlled high quality research has not been conducted. The 1996 survey shows that the uptake of immunisation by Pacific Island populations

Table 1. Demographic characteristics of participants

Sample	%	Sample size N=500
Age		
Under 20 Years	1	5
20–24 Years	11	55
25–29 Years	25	125
30–34 Years	38	190
35–39 Years	20	100
40 plus Years	5	25
Region		
Auckland	39	195
Wellington	14	70
Other North Island	27	135
Christchurch	10	50
Other South Island	8	40
Ethnicity		
European	69	345
Mäori	9	45
Pacific Island	7	35
Asian	2	10
Indian	3	15
Other	9	45
Refused	–	–
Joint Income		
Under $20 000	9	45
$20 000 – $30 000	13	65
$30 001 – $40 000	14	70
$40 001 – $50 000	13	65
$50 001 – $70 000	14	70
$70 001 – $100 000	13	65
$100 000 plus	7	35
Refused	17	85
Education Level		
Primary	–	–
Secondary	45	225
Technical/Trade certificate/Teachers Certificate	24	120
University Degree or Professional Qualification	30	150
Some other level of education	1	5
TOTAL	100	500

was lower (53%) than Pakeha/European and that of Mäori was the lowest at 44.6% by the age of two years. These coverage rates are well below the targets of 95% immunisation coverage of all New Zealand children in 2000, set by the Ministry of Health in 1995.[10]

Parental knowledge of vaccination and the diseases that vaccines protect against is an important determinant in the decision to vaccinate their child.[3,5,11,12] Concerns about vaccines, even without scientific support, have the potential to erode the public's confidence and support for the immunisation programme. The low vaccine uptake in NZ has resulted in outbreaks of preventable disease. Measles epidemics continue (last in 1997) and NZ is currently experiencing a whooping cough epidemic. Internationally, poor confidence in the pertussis vaccine during the 1980s led to epidemics of whooping cough in many Western countries.[13]

Results of the Regional Immunisation Coverage Surveys from all Area Health Boards, in consultation with the New Zealand Communicable Disease Centre, in 1992 found that in general, caregivers throughout the country expressed a desire for more information from vaccination providers regarding immunisations. Depending on region, 2%–8% of caregivers felt that immunisations were not important.[10] In 1996 this sentiment was held by 3.7%–10% of caregivers, depending on region.[8] Concerns have been expressed that lack of confidence in vaccination may be a growing problem and contributing to the ongoing low coverage rates.

To better understand the knowledge, attitudes and misconceptions of parents about vaccines and vaccine preventable diseases, a telephone survey of parents of young children was undertaken. As a key time to inform parents about vaccination is in the antenatal period, we also investigated whether or not the parents had found the information given to them antenatally adequate to make an informed decision about immunising their child.

Methodology

A telephone survey was commissioned from NFO CM Research (National Family Opinion; Central Market Research), a leading market research consultant in New Zealand. The sample size of 500 New Zealand mothers with a child in their household younger than, or up to 18-months of age would be expected to enable an accurate range of views and enable inclusion of at least some members of a variety of ethnic groups.

> **Questions gauging knowledge and attitudes were centred about disease severity, efficacy of vaccines and disease transmission**

Potential respondents were identified by two methods. The first method was used to conduct continuous face-to-face surveys in 16 main urban areas. A random walk methodology was conducted over 50 weekends a year. When conducting door-to-door surveys the researchers will go to a representative sample of a city's streets using maps (streets considered too dangerous for an interviewer are excluded).

An interviewer will go to their designated street and start from an address marked on the map, knocking on each consecutive door. If there is no answer they will try again later. If the time is inconvenient but an appointment is procured they will return later. If a refusal, they will move on to the next address. When they complete six interviews it is termed 'a cluster of six'. The cluster is predesignated but always small. Once this is completed they move into another area and another map. When they return to the area for another survey they will start interviewing at the point they finished previously. This approach ensures a good cross representation of respondents.

Using this method, households containing mothers of young children were identified to be telephoned for this survey. This sample pool was supplemented from a database where the required respondent had been interviewed for a previous survey and had given permission to recontact them.

A standardised interview schedule was developed based on a large UK survey that highlighted areas where parents lacked understanding.[11] Questions gauging knowledge and attitudes were centred about disease severity, efficacy of vaccines and disease transmission. Parents were asked where they obtained their information about immunisation and how they felt about the information they had received. Quantitative and qualitative comments were sought.

The survey was carried out between the 18th April and 11th May 2000 encompassing national urban areas.

Statistical analysis

Sample error for prevalence estimates has a maximum of 4.4% expressed at a 95% confidence level. The Chi Square statistic was used to test for differences between subgroups. Data handling and analysis was done using Surveycraft and Epi Info 2000.

Table 2. Breakdown of Lead Maternity Caregivers used by participants

LMC type	Total %
Midwife Independent	45 (n=225)
Midwife Hospital	17 (n=85)
Doctor or GP	20 (n=100)
Specialist/Obstetrician/Gynaecologist	18 (n=90)

Results

A total of 1 266 households were approached and 818 fitted the inclusion criteria. Of these, 61% completed interviews. The 318 who did not participate in interviews could be classified as the following: Appointment not completed n=7, unobtainable n=274 and refusal n=37. Table 1 shows the demographic characteristics of the sample surveyed.

Lead Maternity Carers (LMC) reported by a survey of New Zealand mothers

Sixty-two per cent of mothers used a midwife as their primary carer during their last pregnancy, 45% of these respondents identified their lead maternity carer as an independent Midwife (Table 2). Only 12% of Europeans used a midwife from a hospital compared with 37% of NZ Mäori. The use of a specialist increased with age, with 42% of women over 40 using a specialist.

Of those who did recall receiving information on immunisation, 289 (58%) received it from their LMC.

Table 3 shows responses of mothers to specific statements about immunisation. Answers to the statements covered a spectrum from strongly agree, somewhat agree, neither/nor, somewhat disagree to strongly disagree and don't know.

Subgroup comparisons

Examining responses with respect to LMC status of the mother showed that:

- Respondents who used a midwife as their LMC were less likely to perceive measles as serious to children compared to those who saw a doctor (84% compared to

Table 3. Summary of agreement with statements made to mothers in New Zealand about immunisation

	Strongly Agree %	Somewhat Agree %	Total Agree %	Neither/ Nor %	Somewhat Disagree %	Strongly Disagree %	Total Disagree %	Don't Know %
Measles can be a serious disease for young children.	67	20	87	3	5	2	7	3
Vaccines are generally effective at preventing these diseases.	62	26	88	2	4	3	7	2
If you keep children clean, well fed and otherwise healthy they will not catch these diseases.	8	10	19	4	24	52	76	1
Breastfeeding stops children from catching these diseases.	8	18	27	6	30	32	62	5
Parents and caregivers have a responsibility to ensure children are immunised to prevent these diseases from spreading in the community.	78	11	90	3	2	4	6	1
Whooping-cough is **not** a serious disease for young children.	6	3	10	1	6	81	87	2
General immunisation of children helps to protect those children who cannot be immunised themselves due to illness.	48	25	73	4	7	8	15	7
Childhood diseases are no longer around much so you don't have to worry about immunising against them.	4	4	8	2	15	75	89	1

92% respectively) Chi square 4.74 (df 1), P = <0.029.

- Those who utilised midwives were more likely to agree that breastfeeding stops children from catching these diseases (30% who saw a midwife compared to 23% who saw a doctor or specialist). Chi Square 4.74 df 1. P<.03.
- The perception that childhood diseases are no longer around so you don't have to immunise against them any longer was more likely to be held by those mothers who saw a midwife than by those who saw a doctor (10% compared to 4%). Chi-Square 4.36, df 1, P<0.04.

Examining responses by age group of the respondent

'Vaccines are generally effective at preventing these diseases'

Mothers over 40 were less likely to agree that vaccines are effective, the mean rate of agreement for this statement was 88%, but only 71% of the over 40 age group agreed (c2 = 7.29, P=0.015 [fisher exact]).

'Parents and carers have a responsibility to ensure children are immunised to stop these diseases spreading to the community'

The mean rate of agreement with this statement among all age groups was 90% however for mothers over 40 there was only 71% agreement (c2 = 7.217, P= <0.007).

'General immunisation of children helps protect those children who cannot be immunised due to illness'

Twenty-nine per cent of mothers over 40 disagreed with this statement compared with an average of 14% among other groups. (Yates corrected c2 =6.02, 1 tailed fisher P=0.013)

'If you keep children clean, well fed and otherwise healthy they will not catch these diseases'

Mothers over 40 were less likely than younger groups to agree with this statement. Under 24, 32%; 25–29 years, 17%; 30–34 years, 19%; 35–39 years, 17%; and over 40 years, 4% (c2 for linear trend 5.045, P=0.025).

Examining responses by ethnicity

'Breastfeeding stops children from catching these diseases, such as whooping cough and measles.'

Ethnic groups other than European and Mäori were more likely to agree with this statement; 24% compared to 47% (c2 = 20.71 p=<0.05).

'If you keep children clean, well fed and otherwise healthy they will not catch these diseases.'

There was wide variation in responses between ethnic groups to this statement. Thirteen per cent of Europeans agreed, 26% Mäori, 45% Pacific Island, 58% Asian, 40% Indian and 22% Other (c2 = 4.29, P<0.05).

'Childhood diseases are no longer around much so you do not have to worry about immunising against them.'

Pacific Island (33%) and Asian (33%) mothers were most likely to agree with this statement. European (4%), Mäori (11%), Indian (0%) and Other (9%) were less likely to agree. c2 = 7.2, P=0.0074

Lead Maternal Caregivers and immunisation information

Mothers were asked who discussed immunisation with them during or soon after their last pregnancy and where, if anywhere, did they get information for their child. Of those who saw a midwife as their LMC, 61% recalled discussing immunisation. Of those who saw a general practitioner, 81% recalled immunisation being discussed and of those who saw a specialist, only 20% said they discussed immunisation with them (Chi-square 73.61, 2df P<0.000). Comparing only those who saw a general practitioner with those who saw a midwife showed that recall was higher in the doctor group (yates corrected chi-square 12.72, P<0.0036). Of the respondents who did not discuss immunisation with a midwife, GP or specialist (19% or 96 respondents) but who obtained information from another source, 53% used Plunket. There were 115 (23%) who recalled receiving no information on immunisation.

When asked whether they received verbal or written information, 20% of mothers recall receiving no written information. Over 90% of mothers under 24 and over 40 years of age obtained some sort of written information compared to 75% of mothers between 25 and 39 years. Around 20% of those between 25 and 39 years say they received information only verbally, more than in other groups, (P=0.066 Chi-Square 3.36).

It is possible that mothers immunise more readily with first time pregnancies, but have doubts with subsequent pregnancies

Twenty-two per cent said only the benefits of immunisation were communicated while 21% said potential risks were also mentioned. The remaining key information related to being told about the range of diseases that children can be immunised against, the schedule of administration, and the decision to immunise being the parental choice.

Overall, as a result of what they had been told, the general feelings of the respondents towards immunisation were positive, reinforcing its importance and enabling mothers to make an informed choice. Seventy per cent of mothers agreed that they had received enough information to make an informed decision. This was especially high among mothers under 24-years-old; 93% felt they had received enough information about immunisation.

Key points

- Parental knowledge of vaccination and the diseases that vaccines protect against is an important determinant in the decision to vaccinate their child.
- One in eight of all mothers interviewed were not convinced that vaccination prevents disease, or that measles can be a severe disease.
- Immunisation is not being routinely discussed by Lead Maternity Carers, especially specialists and midwives.

Respondents were polarised about the focus of the information they were given. Forty-three per cent agreed that there was too much focus on the good things about immunisation and not enough on the possible bad things; 48% disagreed.

Just over a third of respondents agreed that the information they received was informative but that they still needed more advice or guidance. Twenty-one per cent felt that there was an element of coercion delivered with the information, feeling that information givers tried to persuade them to have their child immunised. Despite this feeling, very few (6%) felt that this was in any way unfair. The majority felt that the decision was still left with them.

Those mothers with a midwife compared with those attending a general practitioner as their LMC were more likely to say that the information was confusing – 14% compared to 4% respectively (Yates corrected c2=4.97, P=0.026) – and less likely to say they had had enough information for them to make a decision (83% compared to 90% of those who saw a general practitioner).

Decision to immunise

When asked whether or not they immunised their child 19% of the 500 participants declined to answer. Of the 81% who did respond, 95% said yes and 5% said no. The question did not differentiate between those who were fully immunised and those who had begun immunisations but not continued with the programme.

Discussion

The objective of this survey was to establish the general knowledge and attitudes of parents about disease and vaccinations. The survey also established information gained antenatally and investigated whether there were differences in knowledge base related to the main maternity caregiver, the respondent's age and ethnicity.

The findings show that the majority of respondents believe immunisation to be an important way to protect children against serious disease, 88% felt vaccines are generally effective. However, what is of significant concern is that 12% of respondents felt otherwise which, if acted upon by not immunising children, in itself precludes an ability to reach New Zealand immunisation uptake target of 95% set by the Ministry of Health. These attitudes alone would form a barrier to achieving target coverage rates even before the addition of other issues such as contraindications and access to services.

Parents without telephones, those of minority ethnic groups and those on low incomes are under represented in this sample (Dept Statistics 97/98). A sizeable minority declined to answer whether their children were immunised or not. Non-immunisers are potentially among the non-respondents to this survey. This limits the generalisability of the results. Having taken this into account, the mainstream of parents, utilising primary health care services during pregnancy are represented here and this information itself is valuable and surprising, especially as educational levels were high in this group with 30% having a tertiary qualification.

Although there was a very small number of mothers over the age of 40 years (n-24) they were not only least likely to consider measles to be serious but also least likely to consider vaccines effective. Older first time parents may be more questioning and less convinced of the medical model, or parents who didn't question with earlier children but became more concerned with later pregnancies.

It is concerning that about one quarter of respondents thought that breastfeeding and hygiene would prevent these diseases (27% and 19%) respectively. This demonstrates a high level of misunderstanding about what causes vaccine preventable disease, its transmittance and the process of vaccination.

Parents appear to have little understanding about the concept of herd immunity and the protection it offers to those who cannot be immunised or to those individuals who fail to seroconvert to the vaccine. Despite the findings to these questions there was still a strong sense of responsibility toward other members of the community although this is possibly in conflict with other attitudes in this survey such as vaccine confidence and the perceived severity of disease. This is an area that could be explored in future surveys.

This survey suggests immunisation is not being discussed by many specialists and levels of information offered by midwives can be improved. It would be of interest to know whether the omission of immunisation discussion was in part because it was not considered necessary in cases of multiparity, where carers are assumed to be already aware of immunisation issues. The fact that mothers under 24 years were considerably more likely to have received written information than older mothers is indicative of this. It is possible that mothers immunise more readily with first time pregnancies, but have doubts with subsequent pregnancies. There is some anecdotal evidence for this being the case (Immunisation Advisory Centre 0800 help line). Antenatal maternity caregivers need to be more aware of multiparous women's immunisation information needs, and not assume they have a confident and unchanging understanding of immunisation.

Conclusions

In too many cases immunisation is not being routinely discussed by Lead Maternity Carers, especially specialists and midwives. It appears likely that older mothers and those of multiparity are especially overlooked.

Nearly one in eight mothers are not convinced that immunisation prevents disease, nor that measles is a serious disease. A lack of conviction from inadequate information, poor knowledge of the science of immunisation, and poor understanding of the diseases may be contributing to these findings. Educational intervention with LMCs may be appropriate and it is important to follow up mothers at each WellChild check or other opportunity to discuss any concerns they may be experiencing.

The level of lack of confidence over vaccination may be sufficient to prevent the target vaccine uptake rate of 95% set by the Ministry of health in 1995.

Acknowledgements

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8. Petousis-Harris H, Goodyear-Smith F, Godinet S, Turner N. Barriers to childhood immunisation among New Zealand mothers. Papers 8: NZ Fam Phys 2002;29(6):396-401.

Original Scientific Paper

Barriers to childhood immunisation among New Zealand mothers

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ABSTRACT

Parental knowledge of, and attitudes towards, immunisation and the diseases that vaccines protect against are important determinants of a decision to vaccinate children. This study addresses parents' beliefs and perceptions about childhood immunisation and identifies potential and existing barriers. Focus groups and one-on-one interviews were held with New Zealand European and Maori mothers of starters and non-starters of the immunisation schedule.

Six primary themes were identified for parents: fear of vaccination; a belief that vaccination is unnecessary; a lack of knowledge and understanding of immunisations; a negative perception of health providers; difficulty accessing vaccination; and some supportive attitudes towards immunisation.

Parents shared the desire to keep their children healthy and free from harm, but differed in their knowledge of, and attitude towards, immunisation and the diseases it protects against. Changing immunisation behaviour will require a multi-faceted approach while reinforcing positive actions.

Key words

Immunisation, attitude, qualitative research

(NZFP 2002; 29:396–401)

Introduction

Immunisation prevents disease and is one of the most cost-effective public health interventions.[1-3] Since introduction of mass immunisation, considerable international declines in morbidity and mortality have been reported for the nine vaccine-preventable diseases for which the World Health Organisation has recommended the vaccination of children.[1,2,4]

New Zealand (NZ) has had less benefit than many other countries from the improvements to population health made possible by immunisation. This is primarily because the immunisation coverage has never achieved sufficiently high levels. In 1998, according to the United Nations Children's Fund (UNICEF), 102 of the 193 listed countries had immunisation rates for the primary infant series higher than NZ's.[5] For immunisation programmes to be fully effective they must maintain coverage levels of approximately 90–95%.[6] In 1992 the NZ national coverage survey found less than 60% of children were fully immunised by the age of two years.[7] A repeat coverage survey in 1996 in the Northern region found minimal improvement, with overall coverage of 63% fully immunised by age two.[8] There have been no clear improvements since that time.[9] Although data is limited, the 1996 survey shows that Pacific populations' immunisation uptake by age two years was lower (53%) than Pakeha/New Zealand European and Maori was the lowest at 44.6%. These coverage rates are well below the targets set by the Ministry of Health in 1995 to achieve 95% immunisation coverage of all NZ children by 2000.[10]

Parental knowledge of, and attitudes towards, immunisation and the diseases against which vaccines protect are important determinants of the decision to vaccinate their children.[11–15] Concerns about vaccines, even without scientific support, have the potential to erode public confidence and support for the immunisation programme.[16] The low vaccine coverage in NZ has resulted in recurrent outbreaks of preventable diseases such as pertussis and measles.[17]

The 1992 results of the Regional Immunisation Coverage Surveys from all Area Health Boards found that, in general, 68–80% of caregivers throughout the country expressed a desire for more information from vaccination providers regarding immunisations.[8,10] Depending on region, 2–8% of caregivers felt that immunisation was not important. In 1996 this belief was held by 3.7–10% of caregivers, depending on region.[8] Concerns have been expressed that lack of confidence in vaccination may be a growing problem and contributing to the ongoing low coverage rates. In response to these findings, the Immunisation Advisory Centre carried out a national telephone survey of NZ mothers to identify knowledge and concerns about immunisation in 2000.[18] Twelve per cent of mothers in this survey were not convinced immunisation prevented disease, indicating that low level of confidence in vaccination among urban NZ mothers may itself be sufficient to prevent NZ's target vaccine uptake rate of 95% being achieved.

To date, research on parent attitudes towards immunisation in NZ has been fragmented, or focused on specific groups in the population using regional surveys. To implement strategies to increase immunisation coverage in NZ, comprehensive research is required to understand why parents do not get their children immunised, understand changes across ethnic groups, and identify how positive behavioural changes may be achieved.

This study aimed to address parents' beliefs, knowledge, perceptions and attitudes about child immunisation, and identify potential and existing barriers that preclude children aged two years and under from completing the immunisation schedule. Also explored were the decision-making processes used by parents when deciding whether to immunise their child, an examination of parental perceived barriers to immunisation and ways in which these can be overcome.

The low vaccine coverage in NZ has resulted in recurrent outbreaks of preventable diseases such as pertussis and measles

Methods

The participants were Maori and NZ European parents with children aged 18 months to four years. Both focus group and one-on-one interview methods were used. Focus groups allowed like-minded parents to debate the issues and creatively work through their feelings around immunisation. These were supplemented with one-on-one interviews in parents' own homes, to canvass any potential barriers that might not have been discussed in front of others, and to give busy parents with young babies the chance to participate. Focus groups achieved a breadth of understanding of the various issues, which was enhanced subsequently by depth of insight obtained through the personal interviews.

Sampling was purposive. Parents were included from the ethnic groups (NZ European and Maori) and the immunisation status (fully vaccinated, partially vaccinated or unvaccinated) was sought. Ethnic group was elicited by self-identification. For parents who had started the immunisation schedule, immunisation status was verified where possible by a practice nurse or by self-checking the WellChild book. NZ European non-starters were recruited with the cooperation of the Immunisation Awareness Society, the main anti-immunisation/pro-choice group. Discussions and interviews were tape-recorded or notes taken with parents' permission. Facilitators used enabling and projective techniques to allow parents to explore their knowledge of the diseases and vaccines and to enable them to express their beliefs about immunisation at a deep level. Group discussions lasted between two and two and a half hours and interviews one hour.

Separate focus groups and one-on-one interviews were held with starters and non-starters of the immunisation schedule. Starters were further divided into completers and partial-completers of the immunisation schedule. All groups and one-on-one interviews were with Auckland parents and were conducted in the middle of 2001.

Data collection and analysis proceeded simultaneously. Emerging themes, topics, attitudes and behaviours were noted and categorised into meaningful units. Content provided insight into intention and meaning. The researchers immersed themselves in the language of the parents with whom they spoke, and in the context of their lives to uncover meaning.[19] Expressions were observed, including the tone and emphasis of attitudes and behaviours, as well as the degree of directness and spontaneity of expression. Verbatim comments taken from the study are used to illustrate many of the findings.

The researchers immersed themselves in the language of the parents with whom they spoke, and in the context of their lives to uncover meaning

The reliability of this qualitative data comes from the consistency of the findings, noting the similarity of attitudes and needs expressed in different discussions with similar types of parents. Validity was achieved by the use of projective techniques to identify parents' understanding, ideas and statements about immunisation and what actually occurred.[20]

A subset of the participant responses underwent a further qualitative analytical process. Interview responses were collated and analysed to identify themes which were combined through ongoing discussions between three of the researchers and re-reading of the transcripts until consensus was reached. The data was independently triple-coded as a consistency check and discrepancies resolved by adjudication.

Results

A total of seven focus groups and 16 one-on-one interviews were conducted. Numbers of starters and non-starters, and of NZ Europeans and Maori parents, are presented in Tables 1 and 2 respectively.

Table 1. Numbers of starters and non-starters attending focus groups and one-on-one interviews

Immunisation uptake	Focus groups – each of 4–6 parents	One-on-one interviews
Starters	6	12
Non-starters	1	4
TOTAL	7	16

Table 2. Numbers of NZ European and Maori parents attending focus groups and one-on-one interviews

Ethnicity	Number of focus groups – each of 4–6 parents	One-on-one interviews
NZ European parents	4	7
Maori parents	3	9
TOTAL	7	16

A picture emerged of both positive and negative attitudes towards vaccinations. Six primary themes were identified for parents:

- Fear of vaccination;
- The belief that vaccination is unnecessary;
- A lack of knowledge and understanding about vaccinations;
- A negative perception of health providers;
- Difficulty accessing vaccination;
- A supportive attitude towards vaccination.

Table 3 describes these themes, together with associated sub-themes.

Table 3. Emerging themes and sub-themes

Theme		Sub-theme
1.	Fear of vaccination	a) Immediate pain b) Long-term damage
2.	Vaccination is unnecessary	a) Diseases are rare and/or mild b) Own immunity will protect c) Interferes with 'natural' immunity process
3.	Lacks knowledge about vaccinations	a) Unconcerned b) Would like more information
4.	Negative perception of health providers	a) Distrusting – suspicion of provider biases b) Uncaring of the individual/ condescending
5.	Difficulty accessing vaccination	
6.	Supportive of vaccination	a) Informed on benefits and risks b) Positive – implicit trust, family tradition

Fear of vaccination

A strong theme to emerge was a fear of vaccination by a number of parents. This involved both concern about the immediate pain associated with vaccination:

"Well you can see the needle being stuck into the body, the vaccination. And the holding down of the child to enable them to get the needle in them properly, the size of the needle."

...and fear that the vaccination could cause serious long-term damage to the child:

"These vaccinations are quite dangerous in regards to them being brain damaged and just the certain types of effects that the kids get. The rashes that occur after the vaccination has been given. They are quite bad and drowsiness and crying and they got hot and have fevers afterwards and it is quite bad."

"I fear them getting damaged, the side effects".

Vaccination is unnecessary

Many respondents expressed the belief that vaccination is unnecessary. For some this was a belief that the diseases vaccinated against are either rare or mild when they do occur, or irrelevant to their own children:

"I don't think those (the diseases) are very serious."

“I thought that whooping cough is an old-fashioned disease and it kind of doesn’t exist.”

“It is such a tiny minority that die from it and they are probably living in sub-standard conditions.”

Some were of the opinion that a child’s own immunity will protect them:

“We just felt that if we looked after them properly at home and gave them nice clean faces and breastfeed and that was all they needed.”

“Even if they got any of those diseases, all they are going to do is be sick for a few days and get natural immunity and have immunity for the rest of their life.”

For others, this perspective went further, to the belief that vaccinations interfere with the body’s own ‘natural’ immunity process:

“The homeopath said that by choosing not to vaccinate I am choosing to give him a healthier start because from what I understand through her, you start on a back foot the minute you start vaccinating because it actually has quite a powerful effect to weaken the immune system whereas for me breastfeeding and not choosing to vaccinate I have actually strengthened his immune system twofold.”

Lacks knowledge about vaccinations

A lack of understanding about vaccinations emerged strongly from some respondents:

“I don’t know much about it.”

For some there was a general lack of concern to know more:

“Didn’t worry about it. Still not worried about it.”

...but others clearly wished to be more informed:

“I would want to know as much as I could about what the disease itself is. The risks. The risks of vaccination as well.”

Parents who had failed to complete their children’s immunisations rarely spoke of the consequences of the childhood diseases

Negative perception of health providers

Some participants portrayed a negative perception towards vaccination providers. This included a sense of distrust, a suspicion that the health provider had a biased agenda:

“You went to [***], they talk about making an informed choice. The only information they gave me was pro-immunisation”.

A sense of uncaring of the individual, a condescending attitude by the provider, also came through from some of the responses with:

“They make you feel like, belittled, is that the right word? Lower than anyone else, you don’t know anything as a mother.”

“I have had some instances where I have gone back to the doctor and all they have done is tell me off for saying no.”

Vaccination is an effort to access

Difficulty in accessing vaccination services did not emerge as a major issue, but the opinion was expressed that the effort required to take a child to get vaccinated was a barrier to it occurring:

“I think it would be better if they came to your house and hound you at the door. ‘Your kid needs an injection’.”

Supportive of immunisation

The final theme was a positive attitude towards vaccination. For some, this was an informed position with awareness of the benefits and risks:

“We have got an awesome health system that keeps our kids from getting sick and immunisation is one that keeps them from getting measles, mumps and things like that.”

“It helps them in the long run.”

For others, the support was more an implicit trust in the system, and a sense that the family tradition is to vaccinate:

Key Points

- New Zealand has had less benefit than many other countries from the improvements to population health made possible by immunisation.
- A strong theme to emerge was a fear of vaccination by a number of parents.
- Grandparents appeared to have a strong influence for many Maori parents in the decision-making process to immunise.
- Recognising the importance of whanau for Maori in decision-making is essential to support the uptake of the immunisation schedule by Maori parents.

“I was educated to vaccinate.”

“There are no downsides to immunisation.”

Whilst the general themes that emerged were consistent for Maori and non-Maori, there were some key differences for Maori. Conscientious objectors who were Maori appeared to be more likely to have older children who were immunised. These parents had often rejected immunisation completely for their younger children because of the painful experience of immunising their older children and because of the lack of positive reinforcement when immunising. Immunisers who had not completed and were Maori felt that they were judged for being uncaring parents for not immunising. Maori parents interviewed also appeared to have more motivation to take up the three-month and five-month schedule based on awareness of immunisation certificates required by early childhood centres. Immunisers who took a traditional view appeared to take notice of the example from other members of their whanau in immunising. This was somewhat different from NZ European parents who often looked to their friendship networks for guidance. Grandparents appeared to have a strong influence for many Maori parents in the decision-making process to immunise.

Discussion

In today's society, many parents as modern consumers anticipate their individual wants and needs to be considered in health care delivery. They expect to take an active role in their immunisation decisions, although they may have underlying anxieties about this decision-making process. All parents shared the desire to keep their children free from disease and from harm. They appeared to be motivated to complete the immunisation schedule when they perceived that the risk of the disease outweighed the risk of other factors.

A strong maternal belief in the importance of the immune system to provide a 'natural' protection against disease and sickness was apparent. Most mothers believed it important to build their child's immune system through breastfeeding, diet, good hygiene and good mothering. Drugs were often seen as being artificial, in conflict with this idea, and weakening or suppressing the immune system in some way.

The perception that vaccines cause harm and the painful immunisation experience act as barriers to completion. Parents who had failed to complete their children's immunisations rarely spoke of the consequences of the childhood diseases, more often focusing on the harmful consequences of the vaccines or how painful and stressful they found having their child immunised.

Parents need strong reassurance about the vaccine safety

There are two types of barrier to immunisation – emotive and functional. This study focused on emotional not functional barriers. For some mothers there is a confidence in immunisation. Diseases are seen as relevant and they seek certainty in protecting their children from disease. For others, there are varying degrees of apprehension about immunisation and caution about protecting children from diseases that they do not see as relevant, and using vaccines about which they have concerns.

The themes identified in this study can be used to profile parents and to further position parents with respect to immunisation and aid the development of useful, meaningful intervention strategies.

It is important to link immunisation messages to the family group in a way that does not blame or use guilt

Among those that have completed the immunisation schedule there were those who viewed immunisation as an 'insurance policy' against diseases that they believed real and relevant. Also within this group were mothers who immunised their children because it was a traditional practice among their family, whanau or peer group. These parents immunised their children confidently.

Mothers who had begun but not completed the immunisation programme had stopped for differing reasons. Some felt they had vaccinated their children and although not completed they thought their children were protected enough without completing later vaccinations. These parents may have become complacent, perhaps needing reminding of the importance of completing the immunisation schedule along with positive reinforcement. Targeting this group via clear reminders and reasons for completing would be relatively easy.

A further group of parents had begun immunising but then lost confidence in either vaccines or health providers. These parents need help to evaluate the risks and benefits of immunisation and vaccine-preventable diseases. Health providers will be central in offering support and positive reinforcement. However communicating effectively to this group is more difficult and requires considerably more communication resources.

Among parents who have not completed the immunisation programme were a small group who had no knowledge, understanding or awareness of the diseases and the vaccines that protect against them. Recruitment and targeting of this group will be difficult, requiring considerable outreach and resources.

The last group were those who actively choose not to immunise. These parents are genuine and usually very clear in their belief systems. They are unlikely to be swayed by more knowledge or communication strategies. The activities of the anti-immunisation lobby can create fears and myths about immunisation for other parents, especially those who are not confident about immunisation. It is therefore important to develop and implement strategies to limit the impact of these activities.

Parents need strong reassurance about the vaccine safety. Information should be provided with reasoned scientific rationale, and cues for safety such as showing healthy immunised babies should be considered. Immunising behaviour needs to be constantly reinforced, not only to reduce dissonance but to ensure that immunising parents feel positive about their decision and go on to immunise again. Health professionals need to be supported to provide consistent information and armed with messages to reinforce the issue: why parents need to immunise; the advantages and disadvantages of diseases versus the vaccines; side-effects – what might happen; why young babies need to be immunised; good reasons why parents have done the right thing. For Maori, it is important that appropriate media are utilised to provide relevant information.

Recognising the importance of whanau for Maori in decision-making is essential to support the uptake of the immunisation schedule by Maori parents. It is important to link immunisation messages to the family group in a way that does not blame or use guilt. Messages that position children as the centre of the family (its taonga or treasure) and stress the importance of the wellness of children for the family, may be more effective with Maori parents.[21]

A weakness of this study was that only European and Maori parents participated. It was expressed by health providers working with Pacific parents that their low immunisation rates are due to structural rather than emotional barriers, therefore they were not included in this research.

As a qualitative study with purposive sampling, caution must be taken in generalising our findings to the general population. However they can help guide our policy development and further enquiry into optimal vaccination delivery and uptake.

This study has used intensive focusing methods to understand perceptions and attitudes. The saturation of issues allowed key themes to emerge, enabling understanding of the immunisation behaviours of parents who fully immunise, partially immunise and do not immunise their children. These findings can support development of resources and health professional behaviour to promote change among parents to both reinforce their choice to immunise and cultivate confidence in those parents who have concerns about immunising their children.

Recognising the importance of whanau for Maori in decision-making is essential to support the uptake of the immunisation schedule by Maori parents

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Immunisation education in the antenatal period

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ABSTRACT

Background

The antenatal period is known to be an important time for parents' decision-making around immunisation. Historically parents have discussed immunisation issues within the general practice environment. However with most antenatal and early postnatal care now occurring outside the general practice, many parents now have little contact with the general practice. Other antenatal avenues for education are now likely to be their only source of information. There is no definitive research on what information is being disseminated to parents on this topic.

Aim

This study aimed to determine what immunisation literature is provided to parents in antenatal education classes in Central Auckland.

Methods

This small study involved 40 parents recruited from visits to a large Auckland maternity hospital. They were asked a range of questions on what sources of immunisation information they were given in antenatal classes and on their decision-making processes.

Results

Thirty-four (85%) recalled receiving immunisation information during antenatal classes. Twenty-one parents (52%) did not feel they had enough information with which to make a decision, and of the identifiable sources of information given out, nearly half (7/15) included known anti-immunisation literature. Overall, two-thirds considered themselves very likely to immunise, but only one-third felt confident about their decision.

Key Message

Immunisation education needs more focus in the antenatal education arena and provision of anti-immunisation material is inappropriate to support decision-making processes for parents, which needs to be based on reliable, quality information.

Key words

Immunisation, parenting education, attitudes

(NZFP 2004; 31: 303–306)

Background

New Zealand (NZ) children continue to suffer the effects of vaccine-preventable disease because immunisation coverage rates remain insufficient to effectively control disease outbreaks, particularly of pertussis disease.[1,2]

Education alone is unlikely to improve immunisation uptake. However, it is frequently cited as a key element in an overall strategy to improve immunisation coverage.[3,4] International evidence cites critical barriers to immunisation uptake. Strategies to overcome this include support for families to ensure they are aware of the importance of vaccines, parents' knowledge of when immunisations are due and the importance of the timing of vaccinations.[5] Also, the knowledge of health professionals on immunisation has a significant impact on immunisation uptake among their patients.[4,6–9]

Recent NZ research highlights considerable gaps in both the public[10] and professional knowledge bases,[11] particularly those working in the antenatal arena.[6] Fear of immunisation is also a big concern for NZ parents.[12] Historically, lack of understanding of science within the community has translated into loss of confidence in immunisation programmes and poor uptake of vaccines. Graphic examples of this are when the media takes up a specific issue leading to sudden loss of confidence and resultant epidemic outbreaks. This was tragically shown in the 1980s with the whooping cough outbreaks internationally[13] and, more recently with the MMR vaccine/autism fears and measles and mumps outbreaks in the United Kingdom.[14]

The decisions around immunisation can be extremely difficult for parents. With a wide range of frequently conflicting information now available through multimedia sources, the antenatal period is a critical time for parental decision-making processes. NZ data has shown that nearly 90% of mothers make their decision on immunisation in the antenatal period.[15]

In the past, parents are likely to have discussed immunisation issues within the general practice. Significant changes in the way antenatal services are purchased since 1996 has resulted in the majority of pregnant women now having little, if any, contact with their general practice team in the antenatal period. Now the majority of parents receive their antenatal information via their Lead Maternity Carer (LMC) who is usually a midwife or an obstetrician, and via antenatal education classes. Traditionally, these groups have not been involved in immunisation service delivery, and have not been targeted in immunisation education programmes. Very little is known about antenatal education classes and the role these may or may not play in the imparting of appropriate immunisation education. There is no legislative requirement for antenatal classes to include teaching around immunisation.

There are widespread anecdotal concerns that, at times, parents have received misleading and inaccurate information at antenatal classes.

Parents attending antenatal classes are more likely to be first-time parents. The aim of this small study was to explore both the feasibility of recruiting parents during pregnancy and to ascertain what information they were given during antenatal education classes in the central Auckland region.

Methods

Participants were parents, who had attended antenatal classes through any provider, attending a tour of the maternity unit at National Women's Hospital in Auckland. Tours are held three times a week and parents expecting to deliver at this unit are invited to attend a tour and talk about the facilities. At a convenient point during this session, the nurse educator leading the tour introduced the researcher and handed the attendees over to her. The researcher approached the group and invited parents to consent to a short telephone survey about the nature of immunisation information received during their antenatal classes. Consenting parents were followed up within a month of their tour and a telephone questionnaire was administered.

The questionnaire was brief and consisted primarily of questions asking what information was received, whether it was enough to make a decision with, whether it was positive, negative or neutral, likelihood of immunising baby and some demographics. This study piloted the questionnaire including its ease of use over the telephone.

This study had Auckland Ethics Committee approval.

Results

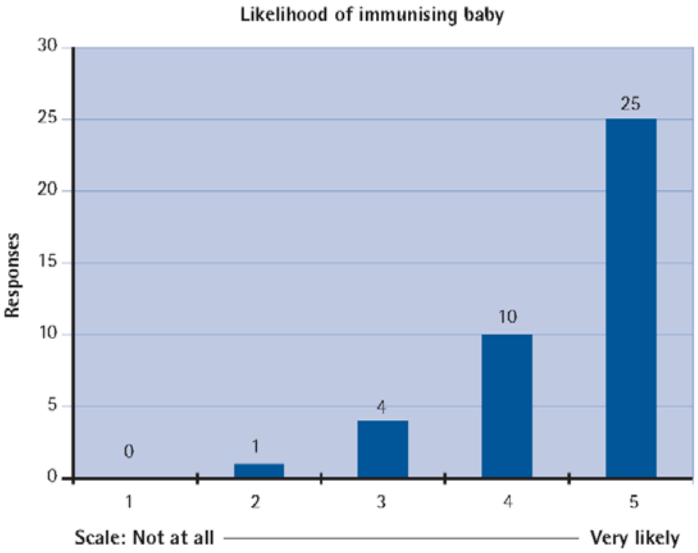
Forty-five interviewees were recruited over nine visits by the researcher. Class size varied from approximately six to 20, which included partners/support persons. Five were unable to complete the interview process due to: Hospital admission (one) and, for the other four, misunderstanding the requirement that participants needed to have attended antenatal classes (this was mainly due to English not being their first language). There were one to two refusals per group.

There were variable numbers recruited from each visit and this was in part correlated with the variable way the researcher and her purpose was presented to the group by the different educators giving the tour.

Most respondents identified as being NZ European 31 (77.5%), two (5%) were NZ Maori, seven (18%) were Pacific, Asian, Indian or UK European. No respondents were under 20 years of age, two were 20–25, thirteen (33%) were 26–30, twenty-three (57.5%) were 31–35 and two were 36–40. None were over 40 years of age. Eight (20%) had a general practitioner obstetrician, four (10%) had a hospital midwife, twenty-one (53%) had an independent midwife and seven (18%) were under a specialist obstetrician for their lead maternity care.

There was a variation in the antenatal classes attended and who ran them. Providers were Birthcare (n=10),

Figure 1. Participants stated likelihood of immunising their baby.



National Women's Hospital (n=13) and four different Parents Centres in the Auckland region (n=13). Four had attended private classes. Parents Centre and other private classes are organised by parent volunteers or by organisations that are independent of the hospitals. These may be recommended to patients by their LMC.

Thirty-four (85%) recalled receiving immunisation information during antenatal classes.

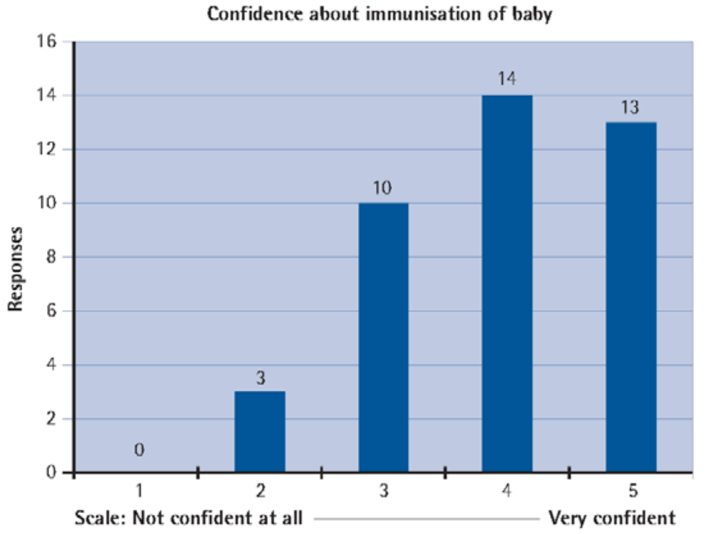
When asked whether this information was written, verbal or both: Twenty-four (60% of whole sample or 71% of sample who had received immunisation information) received both written and verbal information. Ten received written information only.

If written, respondents were asked if they could recall what they were given. There seemed to be many who found this question difficult to answer 'don't recall', 'can't remember' – and in some cases leafing through their folders to see what it was they were actually given. Ten didn't recall what they were given, eight were given Ministry of Health pamphlets only, one was given the Immunisation Awareness Society pamphlet (anti-immunisation literature) only and six were given both Ministry of Health and Immunisation Awareness material. One was given Ministry of Health plus other material, seven were given other material (not Ministry of Health or Immunisation Awareness Society) and for seven, the question was not applicable.

Participants were asked whether they felt the information they had been given was enough for them to make a decision. Nineteen respondents (48%) felt that they had been given adequate information about immunisation to make an informed choice for their baby. Twenty-one respondents (52%) felt they had not enough information with which to make a decision, (16 of these did not think they had received enough and five received nothing).

They were also asked if they felt the information received was (a) positive, (b) negative or (c) neutral towards immunisation. Twelve (30%) felt that the information received was (only) positive towards immunisation. No one felt that the information was (only) negative towards immunisation. Twenty-one (53%) felt that the information received was neutral towards immunisation.

Figure 2. Participants stated level of confidence about immunising their baby



On a Likert scale from 1 (not at all) to 5 (very likely) participants ranked their likelihood of immunising their baby. No participants responded 'not at all', one respondent replied '2', four replied '3', ten replied '4' and twenty-five (63%) replied '5' very likely to immunise (Figure 1).

Confidence in immunisation was measured on a similar scale from '1' not confident at all to '5' very confident. No participants replied not all, three responded '2', ten responded '3', fourteen responded '4' and thirteen (32.5%) responded '5' – very confident about immunising their baby (Figure 2).

There was a statistically significant difference in the responses to these two questions. Although 63% of participants were very likely to immunise their baby, only 33% were very confident about it (Yates corrected (2=6.07, P=0.014).

Discussion

It is difficult for many parents to make fully informed decisions around immunisation. Despite extensive scientific evidence supporting the benefits of the national scheduled immunisation programme, literature is frequently presented in the public domain that is not based around the scientific evidence and includes 'scare stories' and personal opinion. How the literature is presented around immunisation is likely to make a considerable difference to the parent's decision-making processes.

There has been concern for some time in New Zealand regarding the information about immunisation given to expectant parents during the antenatal period. Anecdotal evidence suggested anti-immunisation literature was being distributed either in combination with, or instead of, evidence-based resources. One of the problems in assessing the validity of these claims is the accessibility of parents during the antenatal period when they are attending childbirth education classes. Approaching the classes themselves would severely bias the results. We chose to recruit participants into this study through a tour of the maternity unit of a major maternity hospital where many of them were likely to be first time parents and to have attended antenatal classes through various providers.

This was a small study and the results may not be generalisable to other NZ regions, and some population groups. The study did not have sufficient numbers to compare ethnic differences or age differences and was limited to English-speaking parents with a telephone. However we recruited parents who attended classes through a range of antenatal education providers in the area under study.

Recruitment was relatively straightforward, although the researcher reported that the attitude of the individual educator giving the tour appeared to make a difference in the number of participants recruited at each visit. There are a number of staff at the hospital who give these tours and it is important to have the support of them all when undertaking this type of survey.

Not all parents had received information. Of the 34 (85%) who did, 15 (44%) had literature that was identifiable such as Ministry of Health pamphlets and of these, seven (20%) had received literature known to be anti-immunisation either as well as Ministry pamphlets or alone. Over half of those surveyed did not feel they had been given adequate information with which to make a decision.

There was also an important difference between the likelihood of immunising and the level of confidence in immunising baby. This finding is supported by studies that identify parental fear as an important factor in both parent views on immunisation and immunisation uptake, even among parents who fully immunise their baby.[10,12]

While numbers from this study are small the key findings are concerning.

As it is known that immunisation decision-making occurs, in most instances, in the antenatal arena and parents have a great deal of fear and concerns around the decision, it is urgent and timely to focus more resources and attention on antenatal education. During the antenatal period, there is information provided to parents on a variety of subjects that are important once the baby is born, such as modes of feeding, vitamin K and immunisation. However, this period and shortly after birth are the only opportunities to present information on immunisation issues before the six-week check.

Parents may perceive that literature received from a health professional containing opposing statements is balanced and has equal scientific validity. Furthermore, as immunisation decision-making needs to be based on rigorous science it is unacceptable that education programmes include information that is both misleading and inaccurate.[16] Education programmes need to conform to high standards of quality material to give parents a fair chance of making genuinely informed decisions.

Based on the findings from this small study we recommend further research in this area.

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Understanding and Predicting Parental Decisions About Early Childhood Immunizations

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This research investigated the factors that influence decisions about immunizations. Women in the third trimester of pregnancy ($N = 195$) rated their likelihood of immunizing their child; stated their reasons for and against immunizing; and rated their perceptions of the benefits and risks of immunization, feelings of responsibility, and anticipated regret if harm occurred. Immunization status was determined at follow-up. Stepwise regression analyses demonstrated that immunization decisions are strongly influenced by omission bias factors such as anticipated responsibility and regret variance (which explained more than 50% of variance). It is suggested that parents may benefit from antenatal decision aids that address omission bias and encourage them to assess benefits and risks of immunizations on the basis of scientific evidence.

Key words: immunization, decision making, omission bias, responsibility, regret

The decision whether or not to opt for childhood immunizations can be extremely difficult for parents. Although there is extensive scientific evidence suggesting that the objective benefits of childhood immunizations outweigh the risks, there are also anecdotal reports, including "scare stories," suggesting that immunizations can cause great harm in some instances. It is understandable that, for a parent, any potential risk to a baby is of great concern. The decision is further complicated by the fact that the risk of the disease is dependent on the immunization rate in that community. Parents may have limited information on which to base the decision, or the information they do have may be (or appear to be) controversial, biased, and/or contradictory. A qualitative study (White & Thomson, 1995) concluded that many mothers feel that immunization poses a dilemma, and that when this is so they experience high levels of anxiety when considering the decision. Clearly, interventions are required that aid parents in their decision making, ensuring that the decisions are based on accurate information. The development of such interventions will depend on a better understanding of the factors involved in how immunization decisions are made.

Recent research on health-related decision making is consistent with the view that individuals making decisions actively seek to maximize positive outcomes and minimize negative consequences. This appears to involve weighing up the pros and cons that are immediately accessible and that the decision maker considers relevant at the time the decision is made (Wroe, Salkovskis, & Rimes, 1998). As a result of the person's particular idiosyncratic starting premises, or because he or she focuses on a specific reason or set of reasons at that time, this decision may appear irrational to others who may be using a different set of reasons, such as research evidence. For example, an individual may believe that it is totally unacceptable for something bad to happen because someone has "done" something, but that it is acceptable for something bad to happen because of something "natural" such as disease. So, even if that person believes that the risk of the immunization is lower than the risk of the diseases, he or she may decide not to immunize on the basis of a strong belief about harm caused by action versus inaction, and the extent to which they focus it. The decision outcome may therefore appear irrational to someone who does not hold that belief. Moreover, emotional reasons can also be involved (e.g., anticipated feelings of guilt), causing the decision outcome to stray further from an objective, utilitarian decision.

In immunization decisions, some retrospective studies have suggested that the decision outcome is associated with particular patterns of beliefs. For example, a qualitative study suggested that children's immunization status was associated with parents' beliefs about the relative risks of the immunizations and diseases (Bond, Nolan, Pattison, & Carlin, 1998). It was reported that "immunizers believed that the risks of the vaccination was lower than the risks of the diseases," whereas nonimmunizers were "more concerned about unknown long-term side effects of immunizations than diseases" (Bond et al., 1998, p. 441), which they felt were either rare or not serious. In a study using focus groups and individual interviews (White & Thomson, 1995), it was noted that participants expressed more concerns about the side effects of immunization than about the side effects of childhood diseases. Common parental fears include "overloading the child's immune system," negative effects of the number and mix of immunizations (Meszaros et al., 1996), and the belief that parents can control a

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disease in a healthy child should it develop (Meszaros et al., 1996). Doubts about vaccine effectiveness have also been associated with the decision not to immunize (Meszaros et al., 1996; New & Senior, 1991).

However, further research is required to investigate how the decision is associated with the combination of beliefs, that is, the process by which such beliefs are used in making the decision whether or not to immunize. Emotional reasons also need to be considered; current or anticipated feelings of responsibility, guilt, blame, or regret can be linked to the possibility of harm occurring because of a particular decision (Ritov, Gati, & Tversky, 1990). These emotional reasons may additionally be associated with a bias in decisions known as *omission bias* (Baron, 1988; Spranca, Minsk, & Baron, 1991; Wroe & Salkovskis, 2000). In omission bias, harm resulting from action is considered to be less acceptable than harm resulting from inaction. That is, we tend to be more concerned about things that go wrong because of what we decide to do rather than because of things we decide not to do. If this bias operates in the way people think about immunization, it might be expected that a parent would find it more disturbing to consider harm that happened because they took the child to have an immunization than to consider harm that occurred because the nonimmunized child contracted the disease in question.

If this is so, omission bias could result in a failure to choose the best actuarial outcome because anticipated negative emotions are factored into the decision alongside risk information. In another qualitative study (New & Senior, 1991), it was reported that some participants expressed the view that anything that happened to the child as a result of the immunization against whooping cough would be worse than the child developing the disease, giving reasons involving feelings of responsibility and blame. It has also been demonstrated that when asked about hypothetical immunizations against influenza, participants opposed immunization when the risk of death from the disease was 10 out of 10,000, the vaccine would eliminate the possibility of catching the disease, and the risk of death from the vaccination was 5 out of 10,000, that is, half as likely as death from the disease (Ritov & Baron, 1990). Self-reported nonimmunization against pertussis (whooping cough) has also been found to be associated with both the belief that the immunization is on balance harmful and the tendency toward omission bias (which was defined according to the maximum vaccine risk a respondent would accept and still vaccinate in response to a hypothetical vignette describing risks of death after immunizing and not immunizing; Asch et al., 1994). In particular, some respondents resisted vaccination even though they believed the vaccine to be medically beneficial, and these respondents were more likely to show omission bias.

The aim of this study was to investigate the factors that influence actual decisions about whether or not to opt for childhood immunizations. It is recommended that parents be given information on immunizations by their main antenatal health provider (lead maternity caregiver [LMC]), and that they be prepared in the antenatal period for the choice they will have to make about their child's immunization (Ministry of Health, 2002). Therefore, this research sought to understand the issues that are relevant to mothers at this stage. In particular, the authors investigated mothers' reasons for and against immunizing, how their balance is associated with likelihood of immunizing, and the influence of emotional factors. The second main aim of the study was to ascertain when parents make the immunization decision; a follow-up telephone interview was conducted when the baby was 8–10 weeks to ask about the final immunization decision and when participants felt they had made that decision. The longitudinal design allowed evaluation of the factors influencing actual decisions about immunizations. The design also ensured that participants' responses were not post hoc rationalizations of the immunization decision in which the outcome (e.g., any adverse effects, or lack of adverse effects, of the immunizations) was already known.

Method

Overview

Women (N = 195) who were expecting a baby were recruited through LMCs to take part in a longitudinal study. During the antenatal period, participants completed a questionnaire about their perceptions of the risks and benefits of early childhood immunizations. They were then contacted when the baby was approximately 10 weeks of age to identify immunization status.

Participants

The main antenatal health providers (LMCs) at a large hospital in Auckland, New Zealand, were contacted about the research. Out of 83 LMCs (including midwives, general practitioners, and obstetricians) who were contacted on the telephone and were practicing at that time, 50 agreed to help with recruitment for the study and to be contacted soon after the expected birth date of each baby to ask when the baby was born and whether a follow-up interview was appropriate. These LMCs were then sent flyers and response sheets, with postage paid envelopes (the numbers of which had been ascertained according to the approximate number of clients LMCs thought they were seeing who were potential participants in the study), to give to clients who were in the third trimester of their pregnancy and to whom the LMC had already mentioned immunizations. From a total of 427 flyers sent to LMCs to give to clients, 235 completed response sheets (55%) that were returned to the research group by the clients. These respondents were then telephoned, given more information about the research, invited to take part, and sent the questionnaire with a postage paid envelope; 195 (83%) completed and returned the questionnaire. Demographic information about the participants is shown in Table 1.

Health Care Setting

Participants were asked specifically about immunizations against: diphtheria, tetanus, pertussis (whooping cough), hepatitis B, *Haemophilus influenzae* type B, and polio. Although the Ministry of Health in New Zealand recommends that these immunizations be given at 6 weeks, 3 months, and 5 months, parents are able to chose whether or not to immunize their children. The questionnaire in this study was administered antenatally. A follow-up telephone interview was conducted to ask the outcome of the decision, that is, whether or not the child was immunized, and if so, when in relation to the recommended schedule times. The timing of the immunization is important, because whether the child is immunized on time, late, or not at all has been found to predict immunization status at 2 years of age (Rainger et al., 1998).

Questionnaires and Procedure

Women completed the questionnaire in their own time and returned it in a postage paid envelope. The questionnaire was divided into four main sections.

Section 1 asked participants how likely they would be to immunize the child, how they viewed the information they had received about advantages

Table 1
Participant Demographics

Variable	Participant data ($N = 195$)
Age (years)	
M	32.69
SD	22.64
Educational level (*n*)	
No further education after leaving school at age 16 or 18	48
University degree	56
Other qualifications after school (e.g., diploma)	81
Missing data	10
Relationship status (*n*)	
With partner	173
Single	10
Missing data	12
Number of other children (*n*)	
None	98
One or more	87
Missing data	10
Ethnicity (*n*)	
European origin	151
Maori	18
Asian	5
Pacific Islander	13
Missing data	8

and disadvantages of immunizations, and what their preferences were regarding involvement in the decision to immunize.

Section 2 was an open-ended question asking participants to state all their reasons for and against immunizing their child. They were also asked to rate each reason, indicating how relevant that reason was to them on a scale from 0 (*not relevant at all*) to 100 (extremely relevant). (In order to ensure that participants did not include statements in this section about issues that they had been exposed to in Sections 3 and 4 of this study, at the end of the questionnaire, they were asked not to go back and change any of their responses.)

Section 3 asked about each disease in turn (diphtheria, tetanus, pertussis [whooping cough]), *Haemophilus influenzae* type B, hepatitis B, and polio). Participants were asked to rate:

> How likely do you think it is that your child would develop each disease if
>
> the child is not immunized?
>
> the child is immunized?
>
> no children were immunized? (Scales ranged from 0 [*no chance at all*] to 100 [*definitely*].)

They were also asked to rate

> If the child was not immunized and then developed the disease:
>
> How harmful do you think having the disease would be for your child? (Scale ranged from 0 [*not harmful at all*] to 100 [*the most harmful thing I can imagine*].)
>
> How responsible would you feel for what had happened? (Scale ranged from 0 [*not responsible at all*] to 100 [*totally responsible*].)
>
> How much do you think that you would regret not immunizing your child? (Scale ranged from 0 [*I would not regret it at all*] to 100 [*I would totally regret it*].)

Section 4 asked about effects that are sometimes related to immunizations: soreness, redness, or swelling at the injection site; persistent crying for more than 3 hr, then full recovery; mild fever for up to 3 days; high fever for up to 3 days; not eating properly or vomiting for up to 3 days; drowsiness for up to 3 days; sleeping less than usual or restlessness for up to 3 days; temporary cyanosis (bluish discoloration of the skin with totally spontaneous recovery); shock–collapse (hypotonic–hyporesponsive episodes) with total spontaneous recovery; long-term seizures; brain damage; anaphylaxis (a serious allergic reaction with full recovery); paralysis; and crib death (sudden infant death syndrome). A statement was included at the end of this section to reassure participants that there is no scientific evidence that immunizations cause brain damage, long-term seizures, or cot death, and that there is very low risk (between 1 in 1 million and 1 in 10 million) of a child developing paralytic polio as a result of the oral polio immunization.

Participants were asked about each event in turn:

> How likely do you think it is that this event would occur after the immunization? (Scale ranged from 0 [*no chance at all*] to 100 [*it would definitely occur after the immunization*].)
>
> If your child was immunized and this occurred:
>
> How harmful do you think it would be for your child? (Scale ranged from 0 [*not harmful at all*]) to 100 [*the most harmful thing I can imagine*].)
>
> How responsible would you feel for what had happened? (Scale ranged from 0 [*not responsible at all*] to 100 [*totally responsible*].)
>
> How much do you think that you would regret immunizing your child? (Scale ranged from 0 [*I would not regret it at all*] to 100 [*I would totally regret it*].)

When a follow-up interview was appropriate (based on information from LMCs regarding the outcome of the birth), each woman was contacted when her baby was about 8 weeks old and asked (a) whether the baby was immunized; (b) if so, when the immunization was given; and (c) when the immunization decision was made.

Statistical Analyses of Emotional Factors

In order to assess the extent to which emotional factors predicted the decision, compared with perceptions of physical risks, harm of diseases, and adverse effects, three variables were calculated as scores of perceptions of physical risks and benefits and four variables were calculated as scores of emotional or omission bias factors.

Perceptions of physical risks and benefits. The *perceived individual benefit of the immunization* was calculated for each disease in question as the difference between the perceived risk of developing the disease if the child was not immunized versus the perceived risk of developing the disease if the child was immunized. The product of this score and perceived harm the disease would cause if the child were to develop the disease was calculated. A total score of all 6 diseases was calculated for each individual.

The *perceived community benefits of the immunization* was calculated as the difference between the perceived risk of developing the disease if no children were immunized and the perceived risk of developing the disease if the child was immunized. The product of this score and perceived harm of the diseases was calculated. A total score of all six diseases was then calculated for each individual.

The *perceived risk of the immunizations* was calculated as the product of the perceived risk of each possible adverse effect and the perceived harm to the child if the adverse effect did occur. The total score for all adverse effects was calculated to obtain the final score.

Emotional/omission bias factors. *Feelings of responsibility if harm occurs after inaction (omission)* is the perceived feeling of responsibility if the child was not immunized and then developed the disease. The total score for all 6 diseases was calculated.

Feeling of responsibility if harm occurs after action (commission) is the perceived feeling of responsibility if the child was immunized and then developed the adverse effect. The total score was calculated for all rated adverse effects.

Anticipated regret if harm occurs after inaction (omission) is the anticipated feeling of regret of not immunizing if the child then developed the disease. The total score for all 6 diseases was then calculated.

Anticipated regret if harm occurred after action (commission) is the anticipated feeling of regret of immunizing if the child did develop an adverse effect to the immunization. The total score was calculated for all rated adverse effects.

Results

A majority of participants (67%) stated that they definitely would immunize their child, and 5% stated that they definitely would not. That is, 9 participants rated 0 on the scale from 0 (*definitely will not immunize my child*) to 100 (*definitely will immunize my child*), 5 rated between 10 and 40, 6 rated 50, 44 rated between 60 and 95, and 131 rated 100. Table 2 shows participants' ratings of preferred and perceived amount of information received, and preferred involvement in the decision.

Participants (n = 191) were contacted by telephone when their babies were 8–10 weeks old. Three could not be contacted despite several attempts, and 1 mother was not contacted because she had experienced a stillbirth. Of the 14 participants who rated below 50 on the likelihood of immunization scale, all decided not to immunize; of the 6 participants who rated 50, 2 immunized on time and 4 did not immunize; and of the 171 participants who rated more than 50 on the scale, 146 immunized on time, 16 immunized late (more than 2 weeks after the scheduled date), 7 did not immunize, and 2 did not immunize as a result of severe ill health of the child. The last 2 mentioned participants were excluded from analyses comparing immunizers and nonimmunizers, as the factors potentially influencing the immunization decision had drastically changed. There was a strong association between individuals' antenatal ratings of likelihood of immunizing and their actual immunization decision (η = 0.87). Of those who rated above or below 50 on the decision rating scale, 97% made a decision that would be expected from their antenatal ratings of likelihood of immunizing the child. This allowed analyses of comparisons of individuals who decided to immunize and those who decided not to immunize. One hundred sixty-six participants (88%) stated that they made the immunization decision antenatally, with the remaining participants stating that the decision was made after the child was born.

Participants stated, on average, 2.69 reasons for immunizing their child and 1.78 reasons against immunizing their child. The reasons were categorized into 12 pros (categories of reasons for immunizing) and 18 cons (categories of reasons against immunizing). These are shown in Tables 3 and 4, respectively, together with the percentage of participants who stated them. In order to test reliability of the categorizations, a random sample of 218 reasons

Table 2
Ratings of Preferred and Perceived Amount of Information Received, and Preferred Involvement in the Immunization Decision

Item and score range	No. of participants
How much information do you feel you have on the benefits of immunizations?[a]	
0–40	86
50	72
60–100	27
How much information do you feel you have on the risks of immunizations?[a]	
0–40	19
50	58
60–100	4
How much information would you like to receive about the benefits of immunizations?[b]	
0	5
10–50	15
60–90	87
100	78
How much information would you like to receive about the risks of immunizations?[b]	
0	6
10–50	17
60–90	75
100	87
To what extent would you like the decision about whether to immunize your child to be made by your doctor/nurse/midwife or yourself?[c]	
0	10
10–40	20
50	71
60–90	53
100	31

[a] Scale ranged from 0 (*far too little information*) to 50 (*the right amount of information*) to 100 (*far too much information*). [b] Scale ranged from 0 (*no information at all*) to 100 (*all the relevant and extremely detailed information*). [c] Scale ranged from 0 (*I would like the doctor/nurse/midwife to make the decision alone*) to 50 (*I would like the doctor/nurse/midwife and myself to have equal responsibility in making the decision*) to 100 (*I would like to make the decision alone*).

Table 3
Reasons for Immunizing the Child and Frequency With Which They Were Stated

Reason category	All participants (N = 195)	Participants who immunized on time (n = 148)	Participants who immunized late (n = 16)	Participants who did not immunize (n = 25)
To protect my child against these diseases	10	79	93	64
Community/society benefits	42	43	44	35
General health	18	20	25	8
Low risks of the immunizations, or low risks compared with benefits	14	16	0	4
To allow/help with entry into kindergarten and schools	13	13	25	12
Family values or general attitude	13	15	13	8
High prevalence of the diseases	11	11	0	20
Emotional reasons (e.g., guilt if my child had caught one of the diseases)	10	12	6	4
High severity of the diseases	9	11	0	0
Advice from health professionals	7	7	13	4
Social pressure	4	3	0	12
Low barriers to immunization	4	5	0	0

Note. Data are percentages of participants stating each reason. There were no significant differences for any reason category among those who immunized on time, late, or not at all (ps > .06).

for immunizing and 218 reasons against immunizing were categorized by 2 blind raters, both with expertise in immunizations research. Percentage agreement for pros was 0.92 (κ = 0.87); and for cons, 0.89 (κ = 0.82). Table 3 also shows the percentage of participants who immunized on time, late, or not at all who stated a reason in each category (excluding the 2 who did not immunize because of severe ill health of the child, 1 whose child was stillborn, and 3 who could not be contacted at follow-up). Chi-square analyses were conducted to investigate any differences in the frequency with which reasons in each category were stated by participants who immunized their child on time, late, or not at all.

The total ratings of relevance of reasons for immunizing and the total ratings of relevance of reasons against immunizing were calculated for each of the pros and the proportion of the cons. Decisions balance was calculated as the difference between the pros and cons divided by the total of the pros and cons ([pros − cons]/[pros + cons]).

Table 4
Reasons Against Immunizing the Child and Frequency With Which They Were Stated

Reason category	All participants (N = 195)	Participants who immunized on time (n = 148)	Participants who immunized late (n = 16)	Participants who did not immunize (n = 25)
Side effects (or potential side effects) of the immunizations	63	62	63	72
Pain or distress of injection	12	11	19	12
Preference of "natural immunity"	10	4	6	48***
Mistrust of information from drug companies or government	10	6	6	36***
Low age of child	8	5	6	28***
Emotional reasons	5	1	6	24***
Immunizations are not effective	5	3	0	20***
Possibility of catching the disease from the immunizations	4	4	6	4
Low risk of catching the disease	4	2	0	4***
The idea of putting foreign bodies/germs into the baby	4	1	0	4
Low severity or treatability of the diseases	3	0	0	24***
Mistrust of the manufacturing process	3	1	0	16***
The ingredients of the immunizations (e.g., heavy metals)	3	1	0	16***
High doses of immunizations	3	1	4	8
Aversion to drugs	2	0	4	12
Possibility of the diseases becoming resistant to the immunizations	2	3	0	0
Having read anti-immunization information	2	3	0	0
Barriers to immunizations	1	1	0	0

Note. Data are percentages of participants stating each reason. Except for values marked with asterisks, $p > .06$.
***$p < .01$.

The decision balance was highly correlated with antenatal rating of likelihood of immunizing the baby, $r(191) = .74$, $p < .01$, such that individuals who were more likely to immunize their baby rated a higher relevance of pros compared with cons.

Antenatal Ratings of Perceptions of Risks and Harm of Diseases, and Adverse Effects in Relation to Final Immunization Decision

Repeated measures analysis demonstrated a significant interaction between those who did and those who did not immunize their children and perceived risks of developing the diseases in the following three scenarios: (a) if the child is not immunized, (b) if the child is immunized, and (c) if no children are immunized. This was the case for the five relevant diseases: diphtheria, pertussis, hepatitis B, *Haemophilus influenzae* type B, and polio. As there are no community benefits from tetanus, there were only two scenarios in the analyses. For all diseases, there was a main effect of scenario, $F(1, 187) > 50.0$, $p < .01$ in all cases; a main effect of decision outcome (immunizers vs. nonimmunizers), $F(1, 187) > 4.0$, $p < .05$ in all cases; and an interaction, $F(1, 187) > 25.0$, $p < .01$ in all cases. Further analyses using t tests demonstrated higher ratings by the immunizers than by the nonimmunizers for perceived risk of their child developing the disease if the child was not immunized, $t(187) > 2.50$, $p < .01$ for all diseases; and perceived risk of their child developing the disease if no children were immunized, $t(187) > 3.50$, $p < .01$ for all diseases; and lower ratings by the immunizers than by the nonimmunizers for perceived risk of their child developing the disease if the child was immunized, $t(187) > 2.00$, $p < .05$ for all diseases other than *Haemophilus influenzae* type b, $t(187) = 1.80$, $p = .08$ (see Figure 1).

Participants who immunized their children perceived the diseases as significantly more harmful than those who did not immunize their children, independent $t(187) > 3.90$, $p < .01$ for all diseases.

Perceived risk of adverse effects was rated lower by the immunizers than by the nonimmunizers, $t(187) > 2.80$, $p < .01$ for all adverse effects. This was also the case for ratings of perceived harmfulness of all adverse effects except long-term seizures, brain damage, and cot death, $t(187) > 2.40$, $p < .05$.

The Influence of Perceptions of Physical Risks and Benefits and of Emotional Factors

Analyses were conducted to investigate any differences between immunizers and nonimmunizers in the three factors relating to perceptions of physical risks and benefits (perceived individual benefit of immunizations, perceived community benefit of the immunizations, perceived risk of the immunizations) and the four emotional/omission bias factors (feelings of responsibility if harm occurs after inaction, feelings of responsibility if harm occurs after action, anticipated regret if harm occurred after inaction, anticipated regret if harm occurred after action; see the Method section for description of these factors). It was found that there are significant differences in perceptions of physical risks and benefits such that, compared with nonimmunizers, immunizers had higher ratings of perceived personal benefit of the immunizations, $t(187) = 8.52$, $p < .01$; higher ratings of perceived community benefits, $t(187) = 7.63$, $p < .01$; and lower ratings of perceived risk, $t(187) = 9.21$, $p < .01$. There were also significant differences in emotional/omission bias factors such that, compared with nonimmunizers, immunizers had higher ratings of anticipated responsibility of harm after inaction, $t(187) = 10.23$, $p < .01$; higher ratings of anticipated regret if harm occurred after inaction, $t(187) = 12.69$, $p < .01$; lower ratings of anticipated responsibility of harm after action, $t(187) = -9.21$, $p < .01$; and lower ratings of anticipated regret if harm occurred after action, $t(187) = -8.94$, $p < .01$.

Antenatal ratings of likelihood of immunizing were strongly correlated to both physical perceptions of benefits and risks of immunization: perceived individual benefit of the immunizations, $r(195) = .61$; perceived community benefit of the immunizations, $r(195) = .39$; perceived risk of immunizations $r(195) = -.61$, all ps $< .01$, and emotional variables: anticipated regret if harm occurred after inaction, $r(195) = .77$; feelings of responsibility if harm occurs after inaction, $r(195) = .66$; anticipated regret if harm occurred after action, $r(195) = -.65$; and feelings of responsibility if harm occurs after action, $r(195) = -.59$, all ps $< .01$.

Further analyses were then used to explore how perceptions of physical risks and benefits, emotional/omission bias factors, and demographics contribute to the decision whether or not to immunize the child (regression analyses). Rated likelihood of immunizing the child was the dependent variable. Independent variables were demographics (age, relationship status, first child or not, highest educational level, ethnicity), perceptions of physical risks and benefits (perceived individual benefit of the immunizations, perceived community benefit of the immunizations, perceived risk of immunizations), and omission bias factors (feelings of responsibility if harm occurs after inaction, feelings of responsibility if harm occurs after action, anticipated regret if harm occurs after inaction, and anticipated regret if harm occurs after action). A regression analysis was conducted with all variables allowed to enter freely.

Anticipated regret if harm occurred after inaction was the strongest predictor of likelihood of immunizing the child (predicting 47% of the variance: $R^2 = .47$, adjusted $R^2 = .47$, $p < .01$. This was followed by anticipated regret if harm occurred after action ($R^2 = .57$, $\Delta R^2 = .10$, $p < .01$), feelings of responsibility if harm occurs after inaction ($R^2 = .61$, $\Delta R^2 = .03$, $p < .01$), feelings of responsibility if harm occurs after action ($R^2 = .63$, $\Delta R^2 = .02$, $p < .01$), personal benefits of immunization ($R^2 = .65$, $\Delta R^2 = .02$, $p < .01$), risks of the immunization ($R^2 = .66$, $\Delta R^2 = .01$, $p < .01$), and educational level ($R^2 = .67$, $\Delta R^2 = .01$, $p < .01$). Variables that were not entered ($p > .05$ in all cases) were demographics (age, relationship status, first child or not, ethnicity) and perceived community benefit of the immunizations.

These results suggest that the important variables are the emotional factors, personal benefits of immunization and risks of immunization. In order to investigate more closely variance explained by omission bias factors, we conducted hierarchical regression analyses. Demographics were forced in Step 1, perceptions of physical risks and benefits were forced in Step 2, and omission bias factors were allowed to enter in Step 3.

Demographic variables were found to predict 1% of the variance ($R^2 = .05$, adjusted $R^2 = .02$, $p = .18$); perceptions of physical risks and benefits predicted a further 42% of the variance (cumu-

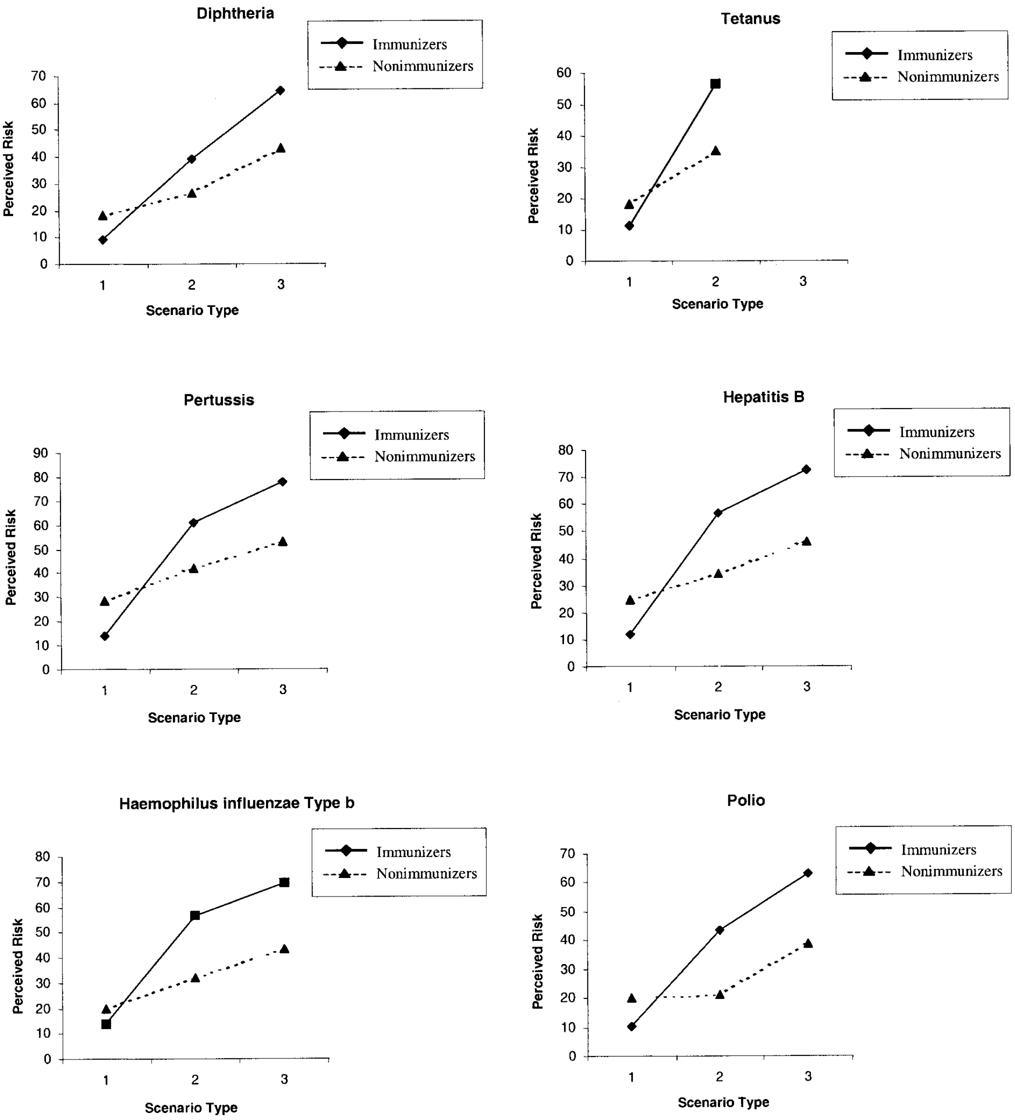

Figure 1. Ratings, by immunizers and nonimmunizers, of perceived risks of each of the diseases. Perceived risks are on a 0–100 scale. Scenario Type 1 = if my child was immunized; Scenario Type 2 = if my child was not immunized; Scenario Type 3 = if no children were immunized.

lative R^2 = .47, change in adjusted R^2 = .42, $p < .01$), and the omission bias factors predicted a further 25% of the variance (cumulative R^2 = .67, change in adjusted R^2 = .25, $p < .01$). The majority of the variance explained by perceptions of physical risks and benefits was in personal benefits of immunization and risks of immunizations.

A residual variable was calculated after regressing personal benefit of immunizations and risk of immunizations onto likelihood of immunizing. Subsequent regression analyses were then conducted, demonstrating that 21% of the variance of the residual was explained by omission bias factors (R^2 = .23, adjusted R^2 = .21, $p < .01$). This was explained by anticipated regret if harm occurred after inaction and anticipated responsibility of harm after action.

Further details of the results of each of the regression analyses are available from the authors.

Discussion

The findings are consistent with the hypothesis that individuals reach their decisions about immunizations by weighing the perceived pros and cons that they see as relevant. The decision is therefore based on idiosyncratic reasons, which often include reasons inconsistent with best available evidence, and on emotional reasons such as feeling of responsibility if harm occurs and anticipated regret. Further analyses into factors that influence the decision, including such emotions, as well as individuals' perceptions of risk and harm of the diseases and adverse effects of the immunizations, suggest that the decision is strongly influenced by the emotional factors, and that this is independent of objective utilitarian factors. Thus, as predicted, omission bias does seem to play a major role in the decision whether or not to opt for childhood immunizations.

The rational weighing of idiosyncratic reasons has been demonstrated in decisions about predictive testing and decisions about using medication (Wroe, 2002; Wroe et al., 1998). The present findings are also consistent with previous qualitative research suggesting that mothers make decisions about immunization by balancing the risks of immunizing with the risks of not immunizing (Bond et al., 1998). Women in the present study gave a wide range of reasons for and against immunizations. The most frequently stated reasons for immunizations were protection against diseases and community benefits, and the most frequently stated reason against immunizations were side effects or potential side effects. Reasons stated by some women that have doubtful scientific basis included preference for natural immunity, the child being too young, and possibility of the diseases becoming resistant to the immunizations. Such reasons were generally stated more frequently by those who did not immunize their children than by those who did, demonstrating their importance in the decision not to immunize. Reasons of this type are often discussed in relation to immunizations (e.g., Bedford & Elliman, 2000). The findings suggest that certain beliefs about immunizations and immunity, for example, a preference to keep the immune system "natural," need to be directly addressed in the information provided by the health professional. Of great concern is that 10% of participants stated that they did not trust the information given about immunizations (e.g., information from the government); many of these participants decided not to immunize their children. Reasons in this category were stated more frequently by nonimmunizers than by immunizers. This matter has also been discussed in previous research (Bond et al., 1998) and clearly needs to be addressed, with the aim of building confidence in public health strategies.

Another important category of reasons is emotional reasons, such as the feeling of responsibility if the child is immunized and experiences an adverse event, and anticipated regret if the child is not immunized and develops the disease. This study suggests that such emotions were strongly associated with parents' decisions whether or not to opt for childhood immunizations. Nonimmunizers have higher antenatal ratings of anticipated responsibility for harm that occurs following action (immunization) and greater anticipated regret of that action. Conversely, immunizers have higher antenatal ratings of anticipated responsibility for harm that occurs following inaction (not immunizing) and higher anticipated regret of that inaction. Regression analyses suggest that emotional factors were a better predictor of the likelihood of immunizing than reasons based on physical risks and benefits. That is, parents may therefore be basing their decision mainly on the perceived acceptability of harm that might result from immunizing compared with harm that might result from not immunizing. The decision may also be biased by the assumption that causing harm by action is less acceptable than causing harm through inaction (Baron, 1988; Spranca et al., 1991). Whereas many previous studies have focused on either hypothetical decisions or retrospective decisions, the longitudinal design adopted in this study suggests that omission bias is also relevant to actual and imminent immunization decisions.

There are a number of potential limitations of the present findings. All participants were women, and immunization decisions are often presumed to be joint decisions between both parents. This makes the near-perfect association between the mothers' ratings and the eventual behavior all the more surprising. It is possible that the LMCs who chose to participate, and the parents who completed the questionnaire, were select groups. Fifty-five percent of the flyers given to LMCs were returned by potential participants. Although most LMCs stated that they had given out most, if not all, of the flyers to clients, it is not possible to know the exact proportion of clients who received the flyers, then returned the form. It is possible that those who did show an interest in the research were particularly interested in issues related to immunizations, which may have exaggerated the effects observed. It may also be that the results obtained were specific to the health care system in which they were obtained (New Zealand). Finally, it is possible that the responses people gave were rationalizations of a decision they had made. It is not possible to know which beliefs are the prime cause of the decision and which are supporting beliefs; it has been proposed that people engage in "belief overkill" in order to justify their decision (Baron, 2000), that is, they convince themselves of the good arguments to support their belief. However, the longitudinal design of the study reduced this possibility, as individuals responses were obtained before a final decision was made. This design also removes the cognitive dissonance issue (the finding that after the decision is made, we give less weight to the reasons that do not support our decision, in order to reduce dissonance; Baron, 2000).

As in previous studies (Wroe, Salkovskis, & Rimes, 2000), the association between prediction of eventual decision given as a rating and the eventual behavior was extremely strong. A majority (88%) of participants stated that they made the decision whether to immunize during the antenatal period. This has implications regarding our approach and the timing of parent education; it supports the recommendation that parents' should be supported antenatally in making the decision (Ministry of Health, 2002) and suggests that any intervention to aid decision making is best conducted at this stage. The usual aim of health professionals is to aid clients in making decisions based on best available evidence (and the way in which this fits with the decision maker's values). When the "objective" benefits outweigh the risks in the decision making process, omission bias may usefully be a focus of any decision-aid intervention, particularly where such factors are found to be distorting the outcomes. One possible means would be to encourage participants to focus on immunizing as a norm, or a scheduled routine, persuading them to think of not immunizing as an active decision to deviate from this norm. Such framing would mean that the decision not to immunize is seen as more of an act than the decision to immunize (Asch et al., 1994; Tversky & Kahneman, 1981).

Baron's research group (Baron, 1992) found that decision makers were more likely to immunize after reading an argument known as the "Golden rule," which suggests individuals put themselves in the position of the child and consider whether they preferred a greater or lesser chance of harm and whether it mattered that these chances of harm came through someone's act or omission. Of 63 participants, 16 originally said they would not immunize, mainly because of feelings of guilt if their child had a bad reaction to the immunization. After reading the "Golden Rule," 6 said they would not vaccinate. Most of those who changed their decisions also changed their anticipated feelings of guilt if harm occurred. Clearly further studies are required to evaluate the use of such interventions on actual decisions whether or not to immunize.

Participants' preference for more information about the benefits and risks of immunizations is evident, and is consistent with other research (Bond et al., 1998; Bright Futures Group, 1999). The findings of this study demonstrate parents' preference for some level of involvement in the decision about immunizations from both the health professional and parents themselves. Further research is needed to evaluate the preferred type and level of detail of information, and how best to aid people in that decision. However, taken together, the results of this study strongly suggest that an antenatal intervention, including the provision of more detailed information on which to base decisions whether or not to immunize, together with a decision aid, such as encouragement to think about the evidence and the issues carefully, would not only be the preferred practice for parents, but would also allow them to weigh the pros and cons on the basis of accurate scientific evidence.

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Evaluation of a Decision-Making Aid for Parents Regarding Childhood Immunizations

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This intervention study evaluates a decision-making aid for parents considering childhood immunizations. Participants (women in 3rd trimester of pregnancy, $n = 100$) rated likelihood of immunizing their child, anxiety, and perceptions of risk of the diseases and immunizations. Individuals were allocated to intervention group (received a decision aid) or control group (received standard care). Ratings were then repeated, and further ratings were obtained when the infant was 10 weeks old. The intervention compared with the comparison condition was associated with significant increase in likelihood of immunizing the infant on time, decreased perceptions of risks of immunizations, increased perceptions of risk of the diseases, reduced anxiety, and increased satisfaction. This intervention may form a useful basis for decision aids in health care settings.

Keywords: immunizations, decision making, decision aid, adverse effects, vaccine safety.

Evaluating the benefits and risks of childhood immunizations can be a complex problem for parents, who are confronted with controversial and often highly emotional information on which to base the decision. The increase in public concern about immunizations is highlighted by the increase in safety-related calls to immunization hot lines (Gellin, Maibach, & Marcuse, 2000). Many feel that they are faced with a "dilemma" and feel highly anxious (White & Thomson, 1995). Studies have demonstrated that parents do not feel that they receive enough information on the benefits and risks of immunizations (Bond, Nolan, Pattison, & Carlin, 1998; Bright Futures Group, 1999) or feel that the information provided is unreliable and biased (Johnson & Joynes, 2001; Wroe, Turner, & Salkovskis, 2004). Together this work suggests that interventions are required to inform parents and to help them in their decision making.

Furthermore, immunization rates fall far short of the target level set by the World Health Organization (WHO; World Health Organization, 1985) of almost universal vaccination coverage by the year 2000. Early childhood immunizations rates in New Zealand have been reported as low as 63% for children aged 2 years (McNicholas & Baker, 1996), and immunization uptake in the Republic of Ireland remains below the target (Harrington, Woodman, & Shannon, 1995) as do uptake rates of measles, mumps, rubella (MMR) vaccine in the United Kingdom (Communicable Disease Surveillance Centre, 2002). Immunization has been described as the most effective health intervention after clean water and sewage disposal and has an extremely high safety record (Ball, Evans, & Bostrom, 1998). Immunizations are among the most successful and cost-effective disease prevention interventions available (World Bank, 1993). Despite this, immunization rates are still clearly a worldwide problem and in order to approach the WHO target, interventions are necessary to improve uptake.

The reasons for relatively low immunization uptake are diverse. Underimmunization reflects not only generally problems of access to health care but also parents' active decisions to forego immunization (Bond et al., 1998; Lennon & Reid, 1994; Meszaros et al., 1996). Lunts and Cowper (2002) reported that of 93 parents of children who had not been immunized (response rate of 71%), only 18% reported difficulty in attending the clinic, 3% gave a medical reason, and the remaining responders gave a reason against immunization such as fear of adverse reactions or "alternative views." Simpson, Lenton, and Randall (1995) also contacted nonimmunizers (response rate 82%) and reported that reasons for nonimmunization were clear in 78% of replies, such as homeopathy and religious beliefs, and that 18% of respondents gave no reason. As well as issues related to access and lack of understanding of the immunization schedule, these studies suggest that a major reason for low immunization uptake is that many parents are making active decisions not to immunize their children. Several studies have been conducted to look more closely at parents' reasons for not immunizing. For example, a retrospective qualitative study suggested that children's immunization status was associated with parents' beliefs about the relative risks of the immunizations and diseases (Bond et al., 1998); it was reported that "immunizers believed that the risks of the vaccination was lower than the risks of the diseases" (p. 445), whereas nonimmunizers were "more concerned about unknown long-term side effects of immunizations than diseases" (p. 445), which they felt were either rare or not serious. In a study that used focus groups and individual interviews (White & Thomson, 1995), it was noted that participants expressed more concerns about the side effects of immunization than about the side effects of childhood diseases. Common parental fears include "overloading the child's immune system,"

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negative effects of the number and mix of immunizations (Meszaros et al., 1996), and the belief that parents can control a disease in a healthy child should it develop (Meszaros et al., 1996); doubts about vaccine effectiveness have also been associated with the decision not to immunize (Meszaros et al., 1996; New & Senior, 1991).

These studies suggest that any decision aid must include the provision of detailed and accurate information about the benefits and risks of immunizations. However, some research has suggested that the provision of information about benefits and risks may have counterproductive effects on uptake of health behaviors (Wolf, Nasser, Wolf, & Schloring, 1996) and that greater participation in decision making increases anxiety (Gattellari, Voigt, Butow, & Tattersall, 2002). It has been proposed that raising the question of whether to opt for childhood immunizations, in particular, measles–mumps–rubella, may alert parents to controversies of which they were previously unaware (Pattison & Pareek, 2001). It has also been stated that physicians often feel it is better policy not to disclose all the possible medical complications of drug treatments because this may "needlessly confuse patients or frighten them into avoiding needed treatment" (Keown, Slovic, & Lichtenstein, 1984). If this is so, then it would be reasonable to regard it as risky to provide information on adverse effects of immunizations as this may discourage parents from immunizing their children. Research is required to improve our understanding of both the kind and level of detail of information that is of benefit to parents in their decision making and the ways in which parents can be helped to balance the information to obtain optimal personal and public health outcomes.

In the development of a decision aid, it is clearly important to understand the decision-making process, that is, how people may use these beliefs to reach a decision as to whether to immunize their child. A more recent study used a longitudinal design to investigate this process and suggested that parents weigh the perceived pros and cons in a rational manner, where these pros and cons include (a) only those on which the decision maker focuses at the time of the decision; (b) the reasons that are inconsistent with the best available evidence; and (c) the emotional factors, such as feelings of responsibility if harm occurs and anticipated regret (Wroe et al., 2004). The study demonstrated that the immunization decision is, in fact, more strongly associated with such emotional factors than with perceptions of physical risks and benefits of the immunizations. These emotional factors have previously been shown to be associated with "omission bias" (Baron, 2000; Spranca, Minsk, & Baron, 1991; Wroe & Salkovskis, 2000a). In *omission bias*, harm resulting from action is considered to be less acceptable than harm resulting from inaction (Ritov & Baron, 1990). That is, people tend to be more concerned about things which go wrong because of what they decide to do rather than because of things they decide not to do. If this bias operates in the way people think about immunization, it would be expected that parents might find it more disturbing to consider harm that happened because they had their child immunized than to consider harm that occurred because the nonimmunized child contracted the disease concerned. Therefore, parents may be making decisions that are rational according to the issues they are focusing on (e.g., the decision not to immunize may be made on the basis of the regret they anticipate feeling if an adverse effect were to occur after the immunization), but this decision may appear irrational to another individual or health professional who is focusing on scientific evidence regarding the benefits and risks. It is evident that any immunization decision aid should also address this issue. The "golden rule" has been proposed to help individuals think differently about decisions that may result in harm following action and inaction (Baron, 1992). The rule states that people can think of the decision from the point of view of the person involved. In the case of immunizations, this would be that decision makers think of the options from the child's point of view and ask whether it is better to have the risk of the adverse effects of immunization or to have the risk of contracting the serious disease(s). It has also been suggested that, in the case on immunizations, decision makers can be encouraged to realize that both deciding to immunize and deciding not to immunize are active decisions. That is, in either case the parent is performing an action; by not immunizing, the parent is making an active decision not to immunize.

Weighing the specific pros and cons that parents are aware of and that they are focusing on at the time of decision making is consistent with the decision-making process described in previous research investigating predictive testing (Wroe, Salkovskis, & Rimes, 1998) and decisions about taking medication as prescribed (Wroe, 2002; Wroe & Thomas, 2003). Leading directly from these findings, it was demonstrated in a series of carefully controlled experimental studies that the specific subset of issues on which individuals focus can be manipulated (by encouraging individuals to carefully consider statements and to rate their personal relevance) and that this strongly influences the decision outcome (Salkovskis, Dennis, & Wroe, 1999; Wroe & Salkovskis, 2000b; Wroe, Salkovskis, & Rimes, 2000). This was the case even when all participants had received the same information and no new information was provided during the "focusing procedure"; that is, all the issues in the focusing procedure had already been mentioned in the information. This procedure can be used to help individuals to consider, and focus on, all of the relevant pros and cons of the options available to them in order to reach the optimal decision outcome.

The study reported in this article investigates the impact of an intervention that includes the following three factors: (a) the provision of more detailed information on benefits and risks of immunizations according to scientific evidence; (b) information on the possible role of emotional factors; and (c) the *focusing procedure*, which encourages individuals to focus on the relevant (and scientifically valid) issues. It is hypothesized that the intervention compared with the control procedure would be associated with an increase in the likelihood of immunizing, an increase in individuals' perceptions of the benefits of immunizations, and a reduction in individuals' perceptions of the risks of immunizations. Because increased perceptions of information exchange between patients and physicians regarding medical decision making has been associated with improvement in psychological variables such as reassurance, anxiety, and satisfaction (Lerman et al., 1990), we propose that the decision aid intervention used here will be associated with increased satisfaction with the decision to immunize and decreased anxiety surrounding immunization. The intention of the decision aid is not only to ensure that parents have an accurate view of the facts about immunization but also the perception that they have a more accurate view.

Method

Participants

Women attending antenatal education classes at a large hospital in Auckland, New Zealand (n = 135) were invited to take part in the research. One hundred women (74%) agreed to take part. One participant in the intervention group completed the preexperimental measures but decided not to complete the study because she felt that the information booklet was biased. However, she agreed to complete the follow-up telephone interview. Therefore, n = 99 for some of the analyses involving postinformation or postexperimental ratings.

Measures

Measures are presented in sections according to the times at which they were used. Items and rating scales were developed through extensive piloting.

Time Point 1 (Preexperimental Measures)

Likelihood of immunizing and anxiety. *How likely is it that you will immunize your child?* (scale range: 0 [*definitely not*] to 100 [*definitely*]). *How anxious do you feel about issues related to immunizations?* (scale range: 0 [*not at all anxious*] to 100 [*extremely anxious*]).

Perceived risk and harmfulness of the diseases. *How likely do you think it is that your child would develop any of the diseases at some point in his or her life if he or she is not immunized?* (scale range: 0 [*definitely not*] to 100 [*definitely*]). *How likely do you think it is that your child would develop any of the diseases at some point in his or her life if he or she is immunized?* (scale range: 0 [*definitely not*] to 100 [*definitely*]). *If your child is not immunized and develops (diphtheria/tetanus/pertussis/hepatitis B/haemophilus influenzae type b[HIB]/polio), how harmful do you think this would be?* (scale range: 0 [*not at all harmful*] to 100 [*the most harmful thing I can imagine*]).

Perceived risk and harmfulness of adverse effects. *If your child is immunized, how likely do you think it is that he or she would experience* (adverse effect)*?* (scale range: 0 [*definitely not*] to 100 [*definitely*]). *If your child is immunized and experiences* (adverse effect)*, how harmful do you think this would be?* (scale range: 0 [*not at all harmful*] to 100 [*the most harmful thing I can imagine*]).

The following were the adverse effects in question: mild fever for up to 3 days, high fever for up to 3 days, not eating properly or vomiting for up to 3 days, drowsiness for up to 3 days, sleeping less than usual for up to 3 days, temporary cyanosis with spontaneous recovery, hypotonic–hyporesponsive episode (HHE) with spontaneous recovery, anaphylaxis, brain damage, long-term seizures, and cot death.

Time Point 2 (Postinformation Measures)

How clear was the information on the (benefits/risks) *of immunization?* (scale range: 0 [*not at all clear*] to 100 [*extremely clear*]). *How much information do you feel you received on the* (benefits/risks) *of immunizations?* (scale range: 0 [*far too little information*] to 50 [*the right amount of information*] to 100 [*far too much information*]). *How useful was the information on the* (benefits/risks) *of immunizations?* (scale range: 0 [*not at all useful*] to 100 [*extremely useful*]).

Time Point 3 (Postexperimental Measures)

In addition to using the measures used in Time Point 1, we also used the following: *How prepared do you feel for the effects of the immunization?* (scale range: 0 [*not at all prepared*] to 100 [*as well prepared as I can imagine*]). 'The Satisfaction with Decision' Scale was developed and validated by (Holmes-Rovner et al., 1996).

Follow-up Measures

Was your child immunized? If so, when? In addition we used items from the Satisfaction with Decision Scale.

Procedure

Participants were asked specifically about immunizations against diphtheria, tetanus, pertussis, hepatitis B, HIB, and polio diseases. The Ministry of Health in New Zealand recommends that these immunizations be given at 6 weeks, 3 months, and 5 months (Ministry of Health, 2002), although parents are able to decide whether to immunize their children. In view of research highlighting the importance of the antenatal period for decision making with immunization (Wroe et al., 2004), the intervention was delivered antenatally.

All participants were allocated to either the control or the intervention group. In order to prevent individuals in each antenatal education class from comparing and sharing information received, we alternately assigned 10 classes (with between 7 and 11 volunteers) to intervention or control, with all volunteers from each class allocated to the same group. Volunteers recruited from the final class (7 volunteers) were allocated according to initial rating of *likelihood of immunizing*, in order to balance the groups in terms of baseline differences in decision rating. Across-group contamination was avoided in these 7 volunteers as the postexperimental ratings were conducted for all participants before their next antenatal class (i.e., before participants met one another again).

Participants were sent a copy of the preexperimental questionnaire in a sealed envelope (see *Measures* section). During a structured telephone interview (Time Point 1), participants were asked to open the questionnaire and to refer to it to rate (a) the likelihood of immunizing and anxiety; (b) the perceived risk and harmfulness of the diseases; (c) the perceived risk and harmfulness of adverse effects that are often related to immunizations, including actual adverse effects (e.g., persistent crying, fever, shock-collapse/HHE, brain damage, long-term seizures, and cot death; see Figure 1 and the *Measures* section).

Individuals in the intervention group were sent an A4-size 20-page booklet titled "Deciding about Immunizations: The benefits and the risks." This covered fairly detailed information about the benefits and the risks of each of the immunizations. There was also a 1-page section on issues related to psychological aspects of omission bias. Participants received information on the possible role of emotions, such as anticipated regret on the immunization decision, and an explanation that decisions are sometimes *dominated by our own natural desire not to do anything that we may regret.* Participants were also informed of the golden rule, which helps people to think differently about decisions, stating that individuals can think of the decision from the point of view of the person involved. In the case of immunizations, this would be that parents think of the options from the child's point of view and ask whether it is better to have the risk of the adverse effects of immunization or to have the risk of the serious disease(s). Finally, it was stated that it is also important to realize that both deciding to immunize and deciding not to immunize are active decisions (i.e., *In either case you are performing an action: by not immunizing your child, you are making an active decision not to immunize*). The control group was sent a less in-depth, standard A5-size 19-page leaflet published by the Ministry of Health titled "Immunization Choices" (Ministry of Health, 2001). This comprised seven sections: Immunization—How Does it Work?, The Immunization Certificate, How Common Are These Serious Diseases?, Childhood Immunization, Questions About Immunization, What Are the Nine Diseases?, and What Are the Risks?.

A few days later (Time Point 2), in a face-to-face interview, each participant was asked to rate (a) satisfaction with the information, (b) clarity of information, (c) amount of information, and (d) usefulness of information on both the benefits and risks of immunizations (see *Measures* section). In order to encourage individuals to think about and focus on

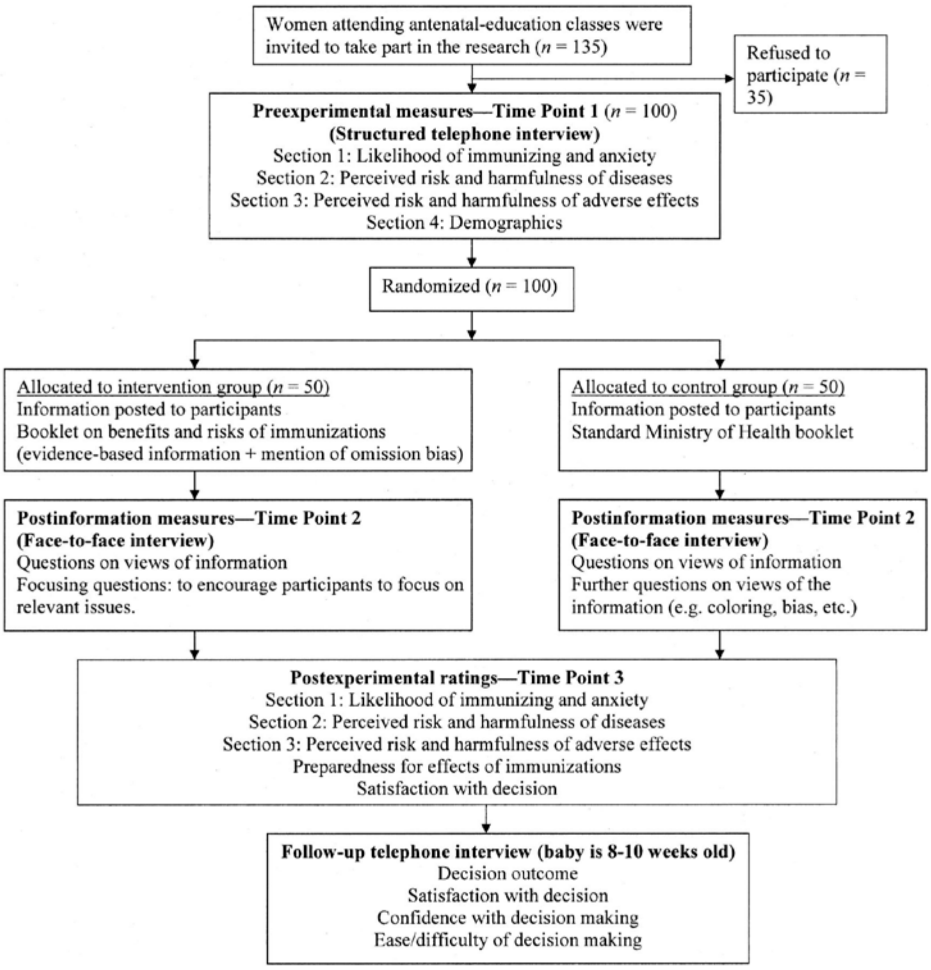
Women attending antenatal-education classes were invited to take part in the research (n = 135)
Refused to participate (n = 35)
Preexperimental measures—Time Point 1 (n = 100)
(Structured telephone interview)
Section 1: Likelihood of immunizing and anxiety
Section 2: Perceived risk and harmfulness of diseases
Section 3: Perceived risk and harmfulness of adverse effects
Section 4: Demographics
Randomized (n = 100)
Allocated to intervention group (n = 50)
Information posted to participants
Booklet on benefits and risks of immunizations
(evidence-based information + mention of omission bias)
Allocated to control group (n = 50)
Information posted to participants
Standard Ministry of Health booklet
Postinformation measures—Time Point 2
(Face-to-face interview)
Questions on views of information
Focusing questions: to encourage participants to focus on relevant issues.
Postinformation measures—Time Point 2
(Face-to-face interview)
Questions on views of information
Further questions on views of the information (e.g. coloring, bias, etc.)
Postexperimental ratings—Time Point 3
Section 1: Likelihood of immunizing and anxiety
Section 2: Perceived risk and harmfulness of diseases
Section 3: Perceived risk and harmfulness of adverse effects
Preparedness for effects of immunizations
Satisfaction with decision
Follow-up telephone interview (baby is 8-10 weeks old)
Decision outcome
Satisfaction with decision
Confidence with decision making
Ease/difficulty of decision making

Figure 1. Study design.

relevant issues more closely, individuals in the intervention group were asked to carefully think about and rate the relevance of statements such as the following.

If my child were immunized:

I would feel glad that I had done my best to prevent my child from developing these serious illnesses.

I would know that there is a chance (up to 1 in 10) of my child having an unusual high-pitched cry; this would be very unpleasant and worrying at the time, but would almost definitely stop after a few hours.

If my child were not immunized:

I would worry about him/her mixing with other children and adults who might be carrying diseases.

To match for time spent interacting with the researcher, we asked individuals in the control group questions on the information, such as layout and coloring.

Following the intervention (Time Point 3), all participants were asked to rate the Time Point 1 items again, as well as how prepared they felt for the effects of the immunization and to complete the validated Satisfaction with Decision Scale (Holmes-Rovner et al., 1996; see *Measures* section).

A follow-up telephone interview was conducted when the child was about 10 weeks of age to determine the outcome of the decision (i.e., whether the child was immunized and, if so, when). If the child was not yet immunized, parents were contacted when the child was just over 3 months old to obtain immunization status. Participants were also asked to complete the Satisfaction with Decision Scale and to rate anxiety about issues related to immunization, confidence in making the decision, and ease/difficulty of making the decision (see *Measures* section).

Ethical approval was obtained from the New Zealand Ministry of Health Research Ethics Committee. Participants were sent the information sheet and consent form to sign and return. Participants were informed that the purpose of the study was to look at what people thought of different kinds of information about immunizations.

Treatment of Data

It was calculated that a sample size of 100 participants per cell (experimental group and control group) was required to permit 80% confidence of detection of a difference of 0.75 standard deviations between the ratings of likelihood of immunizing one's child and long-term satisfaction with the decision (assuming a significance level of .01).

Independent *t* tests and chi-square analyses were conducted to investigate any baseline differences between the groups and to check that there were no confounds as a result of randomization error. Independent *t* tests were then used to investigate any differences in the perception of information received. Repeated measures analyses of variance (ANOVAs) were used to investigate any main effect of group, repeats on the decision rating (likelihood of opting for immunization) and anxiety, and on ratings of perceptions of the risks and harmfulness of diseases and adverse effects. Independent *t* tests were used again to investigate any differences between the groups in preparedness for the effects of the immunization and satisfaction with the decision. Proportional analyses and eta were used to investigate differences in the numbers of individuals who made an immunization decision as would be expected from their postexperimental decision ratings. Finally, chi-square analyses were used to investigate any differences in the proportion of individuals in each group who immunized on time, late, or not at all. Follow-up measures of satisfaction, anxiety, confidence, and ease/difficulty in making the decision were compared through the use of independent *t* tests.

Results

Preexperimental Group Comparisons

There were no significant differences in demographic variables (age, highest educational level, ethnicity, number of children, relationship status) and baseline variables (likelihood of immunizing, anxiety about immunizations) between the intervention and control group (see Table 1). Participants were not aware of the group to which they were allocated.

Perceptions of Information Provided

Independent *t* tests showed significant differences between ratings of perception of the information in the intervention group and the control group(see Table 2).

Ratings of Likelihood of Opting for Immunization

A repeated measures ANOVA (repeated by condition) demonstrated a Condition × Repeated Measures interaction, $F(1, 97) = 20.26, p < .001$. Paired *t* tests demonstrated that in the intervention group postexperimental ratings ($M = 96.51$, $SD = 7.98$) were significantly higher than preexperimental ratings ($M = 81.84$, $SD = 21.69$), $t(48) = 5.25$, $p < .001$, ($M_{\text{difference}} = 14.67$, 95% confidence interval [CI] = 9.06–20.29). In the control group, preexperimental ratings ($M = 82.90$, $SD = 20.75$) were not significantly different from postexperimental ratings ($M = 84.70$, $SD = 21.30$). Independent *t* tests showed no difference between the groups in preexperimental ratings ($t < 1$), but postexperimental ratings were significantly higher in the intervention group than in the control group, $t(97) = 3.64$, $p < .001$, ($M_{\text{difference}} = 11.81$, 95% CI = 5.37–18.25; see Figure 2).

Table 1
Preexperimental Group Comparisons

Variable	Intervention group ($n = 50$)	Control group ($n = 50$)	Comparison
Age			$t(98) = 0.78, p = .44$
M	31.58	30.76	
SD	5.04	5.41	
Highest educational level			$\chi^2 = 2.43, p = .31$
School	12	15	
Tertiary (not university)	13	16	
University	25	19	
Ethnicity			$\chi^2 = 6.24, p = .10$
European descent	33	43	
Maori	4	3	
Asian	7	2	
Pacific Islander	6	2	
Number of children			$\chi^2 = 0.70, p = .40$
None	44	41	
One or more	6	9	
Relationship status			$\chi^2 = 0.71, p = .40$
With partner	46	48	
Single	4	2	
Likelihood of immunizing[a]			$t(98) = 0.39, p = .69$
M	81.20	82.90	
SD	21.94	20.75	
Anxiety about decision[a]			$t(98) = 0.90, p = .37$
M	32.00	37.40	
SD	27.20	32.67	

[a] Ratings of these items were made on a scale from 0 to 100.

Table 2

Perception Ratings of the Satisfaction With, Clarity of, Usefulness of, and Amount of Benefits/Risks, Information Provided to Participants

	Intervention group ($n = 49$)		Control group ($n = 50$)		Comparison difference
Perception	*M*	*SD*	*M*	*SD*	95% CI
Satisfaction	90.00	13.42	79.05	16.65	$t(97) = 3.47$ $p < .001$ 10.95 (4.69–17.22)
Clarity					
Benefits	92.71	12.96	85.00	18.64	$t(97) = 2.30$, $p < .05$ 7.71 (1.05–14.37)
Risks	90.92	14.42	75.95	20.73	$t(97) = 3.93$, $p < .001$ 14.97 (7.61–22.32)
Usefulness					
Benefits	93.37	11.70	85.48	14.68	$t(97) = 2.80$, $p < .01$ 7.89 (2.39–13.39)
Risks	91.94	12.02	75.24	23.40	$t(97) = 4.18$, $p < .001$ 16.70 (9.11–24.29)
Amount (in percentages)					
Benefits information					$\chi^2 = 6.88$, $p < .05$
Too little	2		14		12 (4.59–20.87)
The right amount	86		72		14 (1.97–25.60)
Too much	12		14		2 (−8.24–12.24)
Risks information					$\chi^2 = 20.30$, $p < .001$
Too little	14		60		44 (33.26–57.18)
The right amount	76		36		40 (25.82–52.01)
Too little	10		4		6 (−2.11–14.48)

Note. CI = confidence interval.

Anxiety

A repeated measures ANOVA demonstrated a Condition × Repeated Measure interaction, $F(1, 97) = 4.20$, $p < .05$. Paired t tests showed that in the intervention group postexperimental ratings ($M = 21.43$, $SD = 27.84$) were lower than preexperimental ratings ($M = 31.84$, $SD = 27.46$), $t(48) = 2.29$, $p < .05$, ($M_{\text{difference}} = 5.45$, 95% CI = 0.63–10.28). In the control group, postexperimental ratings ($M = 36.80$, $SD = 32.35$) were not significantly different from preexperimental ratings ($M = 37.40$, $SD = 32.67$). Independent t tests showed no difference between groups in preexperimental ratings, but postexperimental ratings were significantly lower in the intervention group than in the control group, $t(97) = 3.64$, $p < .001$, ($M_{\text{difference}} = 15.37$, 95% CI = 3.32–27.42.

Perceived Risks and Harmfulness of Diseases

A repeated measures ANOVA demonstrated no main effects or interactions for ratings of perceptions of the risk of contracting the diseases ($F < 2$, $p > .18$, in all cases). However, there were significant effects on perceptions of harmfulness of each disease: There were Condition × Repeated Measures interactions ($F > 5$, $p < .05$) for all diseases except HIB, $F(1, 97) = 2.91$, $p = .09$. Further analyses demonstrated significant increases in the intervention group (paired $t > 2$, $p < .05$) relative to the control group.

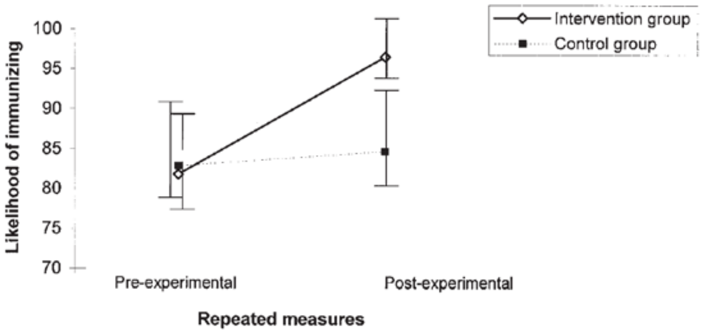

Figure 2. Rated likelihood of immunizing in intervention and control groups.

Perceived Risks and Harmfulness of Adverse Effects of Immunizations

Analyses demonstrated a significant decrease in perceptions of the risk of brain damage, anaphylaxis, and cot death in the intervention group (paired $t > 3$, $p < .005$, in all cases) compared with the control group (interaction $F > 8$, $p < .005$, in all cases).

Analyses showed significant decreases in perceived harmfulness of many adverse effects in the intervention group (paired $t > 3$, $p < .001$, in all cases) compared with the control group (Condition × Repeated Measures interactions, $F > 5$, $p < .05$, in all cases).

Psychological Variables

Independent t tests demonstrated that the intervention group compared with the control group had significantly higher ratings of both preparedness for the effects of the immunization, $t(97) = 6.16$, $p < .001$, ($M_{\text{difference}} = 21.54$, 95% CI = 14.58–28.49), and satisfaction with the decision, $t(97) = 6.05$, $p < .001$, ($M_{\text{difference}} = 4.56$, 95% CI = 3.06–6.05).

Follow-up Measures

Participants' actual decisions whether to immunize their children were strongly predicted by their postexperimental (antenatal) ratings of *likelihood of immunizing.* Of the 90 participants, 86 (96%) made a decision as would be predicted by this postintervention likelihood of immunizing score ($\eta = 0.81$). In the intervention group, 45 (90%) immunized on time (before the child was 8 weeks old), 2 (4%) immunized late (at 8–12 weeks), and 3 (6%) did not immunize (by age 3 months). In the control group, 35 (70%) immunized on time, 6 (12%) immunized late, and 9 (18%) did not immunize, $\chi^2(2) = 6.25$, $p < .05$. This difference was due to a significantly higher proportion of individuals in the intervention group immunizing on time (90% vs. 70%, 95% CI = 8.27–31.20) as opposed to late (4% vs. 12%, 95% CI = −0.44–16.82) or not at all (6% vs. 18%, 95% CI = 2.22–21.88), $\chi^2(1) = 6.25$, $p < .05$. The proportion of participants in each group who immunized compared with those who did not immunize did not reach significance, $\chi^2(1) = 3.41$, $p = .07$.

Follow-up measures of satisfaction with decision were significantly higher in the intervention group than in the control group, $t(98) = 4.54$, $p < .001$, (M difference = 2.65, 95% CI = 1.49–3.81). The intervention group compared with the control group had lower ratings of anxiety, $t(98) = -3.07$, $p < .01$, ($M_{\text{difference}} = 18.34$, 95% CI = 6.47–30.22); had higher ratings of confidence in making the decision, $t(98) = 2.32$, $p < .05$, ($M_{\text{difference}} = 9.04$, 95% CI = 1.30–16.78); and perceived the decision as less difficult, $t(98) = 2.55$, $p < .05$, ($M_{\text{difference}} = 17.73$, 95% CI = 3.91–31.54).

Discussion

The findings of this study suggest that an antenatal decision aid may be of benefit in overcoming the problem of low immunization uptake; it highlights the ability to successfully intervene antenatally to increase uptake of "on time" childhood immunization, reduce maternal anxiety, and improve maternal satisfaction with decision making. This finding is of particular importance because immunization status (on time, late, or not at all) regarding the first scheduled immunization is an important predictor of whether the child is fully immunized at 2 years of age (Rainger et al., 1998). The significantly higher ratings of satisfaction with the decision and preparedness for the effects of the immunization, both of which have been shown to be associated with "sticking" to the decision (Parhiscar & Rosenfeld, 2002; Wroe & Thomas, 2003), would suggest that the effects may be long-term. However, a longer term study with a larger sample size is necessary to clarify this.

The intervention was associated with significant decreases in maternal perceptions of both risks and harmfulness of many of the significant adverse effects, increased perceptions of risk of the diseases, reduced anxiety surrounding immunization, and increased satisfaction with the decision relative to the comparison condition. This is contrary to the suggestion that providing information on adverse effects of immunization will increase anxiety and decrease uptake. Instead, the findings suggest that the provision of information on the risks of even some of the more unpleasant adverse events decreased perceptions of the harmfulness of those adverse effects. It may be that these changes in perceptions of risk and harmfulness of the adverse effects mediated the change in immunization decisions.

There are some limitations of the study that should be noted. First, the sample size was small (50 in each group). Although there were significant differences between the groups in decision ratings and the proportion of individuals who immunized their children on time, it is possible that there would also have been significant differences in the proportion of parents who immunized versus those who did not immunize if the sample size was greater. A longer follow-up is also necessary to investigate the long-term impact on immunization decisions, although, as noted above, the timing of the first immunization (which was significantly different between the groups) has been shown to predict immunization status at 2 years. Unfortunately, participants could not be randomized by individual but instead had to be randomized by antenatal class because of the possibility of participants within each class discussing the study. Randomization to intervention or control group by individual would have been more robust. As several comparisons were conducted, it is important to be aware of the possibility of Type I error; if alphas were adjusted for multiple comparisons, some findings (e.g., decrease in anxiety in intervention group) would appear nonsignificant. However, it may still be productive to consider these effects; some statisticians have argued that adjustments for multiple comparisons can lead to clinically relevant findings being discarded (Rothman, 1990). This is less relevant to the key comparison, that is, that the likelihood of immunizing increased in the intervention group relative to the control group ($p < .001$). The study, which was conducted in New Zealand, may be culturally specific. However, there were no differences between individuals from different ethnic backgrounds. Replication of the study in another country where the decision aid focuses on the particular immunization of concern in that country (such as MMR in the United Kingdom) would also allow us to investigate the generalizability of the intervention to decisions about other childhood immunizations. The study involved parents who were recruited through antenatal education classes; the study was aimed at, and is likely to be specific to, individuals who seek information about parenting issues. This may be seen as a limitation because, as stated above, there are many reasons for low immunization rates, including access issues. However, it is unlikely that the same intervention would be relevant for parents who do not immunize because of difficulty attending the health practice; it is suggested that interventions be developed that are specific to the particular groups. It is possible that there were some differences between the groups simply because of immediate reactions to the booklets, such as their titles ("Deciding About Immunizations: The Benefits and the Risks" or "Immunization Choices") and that the intervention booklet was provided by a research group as opposed to the Ministry of Health. It is known that many individuals do not trust the information they are provided by health services (Johnson & Joynes, 2001), so participants in the intervention group may have believed the information from the researchers to be less biased. Further research is required to address this issue. Finally, the study was not blind. However, this would not be the case for the main outcome variable which is the objective measure of immunization status.

Because the intervention differed in three main ways from the control procedure (i.e., the level of detail of information on the benefits and the risks of immunizations, an explanation of omission bias, and the focusing intervention), it is not possible to pinpoint any single influential factor: Is the information alone sufficient, or is the focusing procedure required for a significant effect? The findings do not inform us whether the difference in immunization decisions between the groups was influenced by the information describing the possible role of emotional factors and omission bias. If this aspect does play a role in the decision change, it would be particularly interesting to investigate whether the change is a result of the presentation of the golden rule or a result of encouraging parents to reframe the way they view their decision so that decisions both to immunize and not to immunize are perceived as actions. This study could provide the first step of experiments to investigate factors that influence parents' decisions about childhood immunizations. Clearly, further research is needed to improve understanding of the specific factors involved in the decision change. Meanwhile, the study provides a basis for the further development of decision aids suitable for health care settings.

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Call for Nominations

The Publications and Communications (P&C) Board has opened nominations for the editorships of **Behavioral Neuroscience, JEP: Applied, JEP: General, Neuropsychology, Psychological Methods,** and **Psychology and Aging** for the years 2008–2013. John F. Disterhoft, PhD; Phillip L. Ackerman, PhD; D. Stephen Lindsay, PhD; James T. Becker, PhD; Stephen G. West, PhD; and Rose T. Zacks, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 2007 to prepare for issues published in 2008. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations also are encouraged.

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Deadline for accepting nominations is **January 20, 2006,** when reviews will begin.

12. Mueller S, Exeter DJ, Petousis-Harris H, Turner N, O'Sullivan D, Buck CD. Measuring disparities in immunisation coverage among children in New Zealand. Papers 12: Health Place 2012 Nov;18(6):1217-1223.

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Measuring disparities in immunisation coverage among children in New Zealand

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ABSTRACT

For the past 20 years, New Zealand has experienced low immunisation coverage levels. Following the introduction of the National Immunisation Register (NIR) in 2005 many practitioners envisaged improved overall immunisation uptake through enhanced surveillance and monitoring capacities. This study aimed to investigate the geographical distribution and variables associated with disparities in immunisation uptake in New Zealand using a large NIR data set of children aged 12 months old in 2007–2009. DHB immunisation uptake was adjusted for individual ethnicity and deprivation status, year of birth and geographic location. Substantial variations in uptake by ethnicity and District Health Board (DHB) level were evident. Māori (NZ indigenous) and 'Other' ethnicity remain a substantial risk factor for low immunisation uptake after controlling for socio-economic deprivation. In addition, a general north–south gradient was confirmed across New Zealand. Current immunisation programme strategies for planners and providers in New Zealand need to recognise varying DHB compositions in order to provide efficient service provision and to focus on those groups at higher risk of not being immunised.

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1. Introduction

Childhood immunisation programmes are one of the most effective public health interventions of the last century (Brundtland, 2002). Vaccines have developed extensively from early observations and experimentations to become one of the most well researched areas of medicine underpinning modern health policy (Marr and Malloy, 1996). In New Zealand, immunisation programmes have contributed to the elimination of endemic diphtheria and polio, significant reductions in tetanus, Hib disease, measles, mumps and rubella although there are still outbreaks of measles and epidemics of pertussis (Turner et al., 2000; Ministry of Health, 2007). The measurement and regular monitoring of immunisation coverage levels is a crucial instrument to assess performance of programmes and to identify vulnerable populations. Coverage monitoring provides opportunities to improve immunisation service delivery and to guide initiatives to specifically address at-risk populations.

Historically, immunisation coverage estimates in New Zealand relied primarily on retrospective surveys and were based on small population samples (Rainger et al., 1998; Ministry of Health, 2007). These coverage estimates enabled the inferences for large populations but did not facilitate more detailed investigations at smaller scales, or for specific populations (Department of Health, 1992; Rainger et al., 1998; Ministry of Health, 2007). However, within the past 10–15 years, there has been a substantial development in the technological capabilities for the collection and monitoring of immunisation data. Surveillance systems, such as New Zealand's National Immunisation Register (NIR) which was introduced in 2005, have been progressively implemented into health care systems worldwide and provide faster and more efficient surveillance and monitoring capacities than traditional survey assessments. Immunisation uptake can now be analysed using readily available data stored within the New Zealand NIR - instant coverage assessments are now feasible for at-risk populations, birth cohorts and for various geographical scales (Ministry of Health, 2004a; Khare et al., 2006; Mahon et al., 2008; Hull et al., 2009).

This study describes the immunisation coverage status for New Zealand infants between 2007 and 2009 and evaluates risk factors for lower uptake using a national cohort of 12-month-old children derived from the recently introduced National Immunisation

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Register (NIR). We investigated immunisation uptake rates in the 21 District Health Boards (DHBs) in New Zealand and across demographic characteristics such as deprivation and ethnicity in order to identify possible disparities in immunisation coverage levels between geographic locations and at-risk populations.

2. Data & methods

Anonymised immunisation data for this study was obtained from the National Immunisation Register (NIR), and was provided by the Ministry of Health. The NIR automatically records each child born in New Zealand at birth and thus provides a complete account of all birth cohorts since implementation in 2005. Reporting immunisations back to the NIR is fully integrated and happens automatically so long as the vaccinator enters the immunisations given into the Practice Management System at the respective General Practitioner office (Ministry of Health, 2004a).

The data extraction included all children recorded in the NIR who turned 12 months of age between 2007 and 2009. Individual immunisation status was defined as the completion of all vaccines for the three immunisation events required by the National Immunisation Schedule for each child before 12 months of age. The national schedule states that immunisations are due at 6 weeks, 3 months and 5 months of age. During the study period, the schedule underwent changes in June 2008 with respect to the type of vaccines used (Ministry of Health, 2008a). In the 2008 schedule the core course of immunisations was reduced from six (2006 schedule) to three injections while providing identical disease coverage (diphtheria, tetanus, whopping cough, polio, hepatitis B, influenza type b). As a result, the total count of immunisations depends on the date of birth of the child and the respective immunisation schedule. Moreover, there was an epidemic meningococcal vaccine (MeNZB^{TM}) delivered to all infants from 2004 to 2008 and the conjugate pneumococcal (PCV-7) vaccine which was added to the schedule in mid-2008: these were excluded for this study.

The denominator comprised all eligible children who turned 12 months between 2007 and 2009. Voluntary opt-outs (children who were removed from the register by their parents) were omitted for analysis due to a lack of information on their status. The 'opt-out' flag does not provide further details on the reasons for removal from the register, but examples might include: the parents having privacy concerns regarding the register's function, or non-compliance with the immunisation schedule. The numerator contained the counts of all eligible children who had a complete immunisation status. The immunisation data were additionally stratified by ethnicity and area-level deprivation.

Data on the child's ethnicity was obtained from the register and coded using the NZ prioritisation approach whereby a child's parents with multiple ethnic affiliations are categorised in order of priority according to perceived need (for New Zealand): Māori, Pacific, Asian, New Zealand European and 'Other' (Ministry of Health, 2008b). For example, an individual that identified as being 'New Zealand European' and 'Pacific' was defined in this data set as 'Pacific' due to the higher priority classification for Pacific Peoples. The rationale behind this prioritisation process is to ensure that ethnic groups of policy importance (e.g. minority groups) or of small population sizes are not masked by the dominant New Zealand European/'Other' group when some form of data reduction is required (Ministry of Health, 2004b, 2008a).

Each patient record provided by the NIR was assigned a spatial reference as a Meshblock (MB) ID, which represents an area where the address given by the parent or care-giver at first contact with the health care system after birth is located. The MB level is the smallest level of aggregate Census data collection in New Zealand. The 41,392 MB contain approximately 40 people in rural areas and on average 110 people in urban settings (Statistics New Zealand, 2006).

Socio-economic differences were measured using the 2006 New Zealand Deprivation Index (NZDep2006, Salmond et al., 2007a; White et al., 2008). NZDep2006 is computed based on small area socio-economic data and comprises nine variables representing both material and social deprivation in the population (e.g. income, unemployment, qualifications, and household characteristics such as overcrowding) which are from the 2006 New Zealand census. We converted the deprivation quintiles commonly used health research in New Zealand into a three-tier category where the first two quintiles (NZDep 1-2 and 3-4) are assigned 'low', NZDep 5-6 'medium' and NZDep 7-8 and 9-10 'high' deprivation to investigate disparities in immunisation rates by socio-economic status at the MB level (Salmond et al., 2007b). Immunisation uptake rates for all eligible children were calculated for each ethnic and deprivation categories on a national scale, and also separately for all 21 District Health Boards (DHB) in New Zealand.

DHB immunisation uptake was adjusted for individual ethnic background, deprivation status and year of birth in addition to geographic location (North/ South Island) using a multivariate lognormal regression model assuming a Gamma distribution. Based on the same regression model assumptions separate analysis was carried out to analyse the effect of ethnicity E, deprivation D and the combined interaction of the two with the underlying population proportion PP in the respective ethnic and deprivation categories on mean immunisation uptake $IMMS$ across all DHBs in

$$\ln(IMMS) = \beta_0 + \beta_1 * PP + \beta_{ij} * D * E * PP$$

where $\beta_{ij}, i = 1,2,3, j = 1,\ldots,5$, is the matrix of β estimates for the population proportion in each category of the combined interaction of deprivation i and ethnicity j. Significance level was set to $\alpha = 0.01$ and all statistical analyses were calculated using SAS 9.2[1].

3. Results

Study population: The original data set provided by the NIR included a total of 187,533 anonymised records for the study cohort of children aged 12 months between 2007 and 2009 with demographic information attached. In total 26,303 records (14%) were excluded from the original data set. These included missing spatial references (i.e. MB ID) and NZDep2006 scores (Salmond et al., 2007a; White et al., 2008), which accounted for 8% and 2% of the exclusions, respectively. Records flagged as opt-outs made up 4% of all exclusions and were additionally omitted from the analyses as there is no clear knowledge/information about the immunisation status of those children: children may be immunised but the parents do not wish to be tracked, while others may not comply with immunisation altogether and/or do not like to be monitored as well. As a result, the final data set for this study included 161,230 records.

Immunisation coverage: National and District Health Board (DHB) immunisation coverage rates were calculated for children turning 12 months between 2007 and 2009 in New Zealand. During this period, 85.4% (95% CI: 85.2; 85.6) of all eligible children were fully immunised at 12 months, while significant variations were observed among the 21 DHBs across New Zealand (Fig. 1). Twelve DHBs recorded immunisation coverage levels

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[1] PROC GLIMMIX; SAS version 9.2, SAS Institute Inc, Cary, NC.

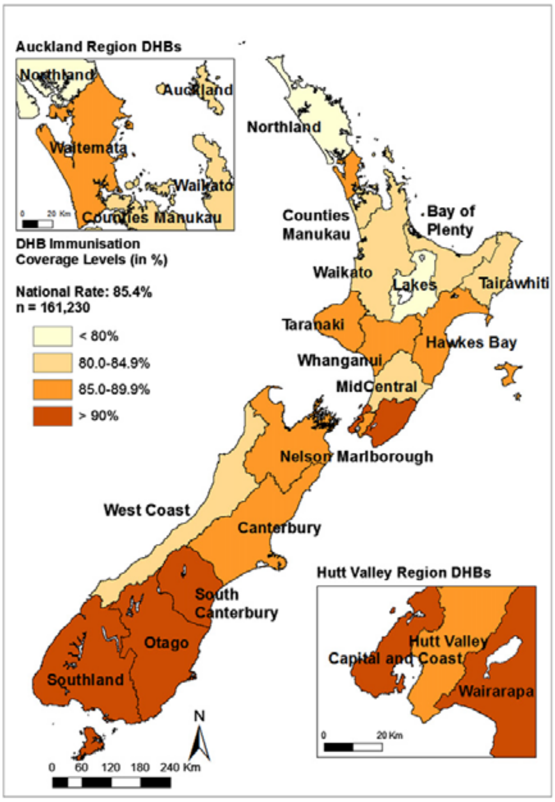

Fig. 1. Geographical distribution of immunisation coverage levels for children aged 12-months.

above the national rate of 85.4%. The highest levels were recorded in the South Canterbury and Otago DHBs with significantly higher uptake rates than the national average with 94.3% (93.2; 95.4) and 94.1% (93.5; 94.7), respectively (see Table A1 for full coverage overview). By contrast, nine DHBs showed immunisation rates below the national average. The Lakes and Northland DHBs had the lowest rates with approximately 75% of children fully immunized. Statistical analyses confirmed a general north–south gradient was apparent, with higher uptake rates in the South Island and decreasing uptake rates for the North Island (Table 1). Furthermore, significant improvements in immunisation uptake were found for subsequent years since implementation of the NIR (reference category=2008; Table 1).

To address possible effect changes due to the omission of the records that were flagged as opt-outs, sensitivity analyses were performed for data sets which contained the opt-out records in the denominator. While the immunisation uptake rates decreased expectedly due to the increased number of 'unimmunised' children when including the opt-outs, the effects (risk estimates) remained similar compared to the restricted data set (data not shown).

3.1. Immunisation coverage by deprivation

Fig. 2 demonstrates immunisation coverage levels by deprivation for New Zealand and shows that children living in the least deprived areas ('low') comprised 89.0% (95% CI: 88.8; 89.3) of the population fully immunised, compared to only 81.8% (81.5; 82.1) among those living in the most deprived areas ('high'). Children living in 'medium' deprivation areas presented 87.5% fully immunized children. The difference between the deprivation categories were statistically significant ($p < .01$), depicting a negative social gradient (also see Table 1). The decrease in immunisation uptake was accompanied by an increase in proportions of population in the 'high' deprivation areas. The population in this category accounted for 45% of the total population and demonstrated 7% and 5.5% lower immunisation coverage rates compared to populations living in the 'low' and 'medium' deprivation areas, respectively. There was approximately 5.6% difference between the two initial NZDep2006 quintiles (NZDep 7-8, 9-10), substantially affecting the mean of this deprivation category (Fig. 2). Similar overall trends were also observed at the DHB level, in particular for the lowest performing DHBs. As deprivation and ethnicity are highly correlated a more detailed analysis controlling for both covariates was conducted to account for the effects of ethnicity and deprivation on immunisation uptake.

Table 1
The effect of ethnicity, deprivation, geographic location, year of birth in addition to the interaction of ethnicity and deprivation on the mean immunisation uptake across all DHBs.

Effect	Deprivation (Dep)	Ethnicity (PE)	Estimate $\exp(\beta)$	95% CL ($\exp(Lo; Up)$)
North Island	.	.	**0.945**	**(0.946; 0.947)**
South Island	.	.	REF	
2006	.	.	**0.983**	**(0.982; 0.983)**
2007	.	.	**0.991**	**(0.990; 0.992)**
2008	.	.	REF	
Dep	High	.	**0.993**	**(0.992; 0.994)**
Dep	Medium	.	**0.998**	**(0.997; 0.999)**
Dep	Low	.	REF	
PE	.	Asian	**0.995**	**(0.974; 0.977)**
PE	.	*rmMā*ori	**0.998**	**(0.975; 0.977)**
PE	.	Other	**0.99997**	**(0.984; 0.986)**
PE	.	Pacific	**0.977**	**(0.974; 0.979)**
PE	.	NZE	REF	
Dep*PE	High	Asian	1.00	(0.999; 1.003)
Dep*PE	High	Māori	**0.98**	**(0.983; 0.986)**
Dep*PE	High	Other	1.00	(1.001; 1.005)
Dep*PE	High	Pacific	**0.99**	**(0.984; 0.990)**
Dep*PE	High	NZE	REF	
Dep*PE	Medium	Asian	1.00	(0.998; 1.003)
Dep*PE	Medium	Māori	0.998	(0.996; 1.000)
Dep*PE	Medium	Other	**1.00**	**(1.001; 1.006)**
Dep*PE	Medium	Pacific	1.00	(0.996; 1.003)
Dep*PE	Medium	NZE	REF	
Dep*PE	**Low**	Asian	REF	
Dep*PE	**Low**	Māori	REF	
Dep*PE	**Low**	Other	REF	
Dep*PE	**Low**	Pacific	REF	
Dep*PE	**Low**	NZE	REF	

3.2. Immunisation coverage by ethnicity and deprivation

Fig. 3 describes the national immunisation uptake rates for the five major ethnic groups in New Zealand stratified by deprivation and depending on the underlying population distribution which is presented in the lower part of Fig. 3. Trends in uptake around the mean DHB immunisation uptake were plotted based on a 5% change in the population proportion within the respective ethnicity and deprivation category to identify effects of the underlying population distribution on mean immunisation uptake (Fig. 3).

When immunisation uptake is stratified by ethnic group (Fig. 3) New Zealand Europeans (NZE) showed the highest mean uptake rate of all ethnic groups with 91.8% (95% CI: 91.6; 92.0) fully immunized children, while the second highest coverage rate

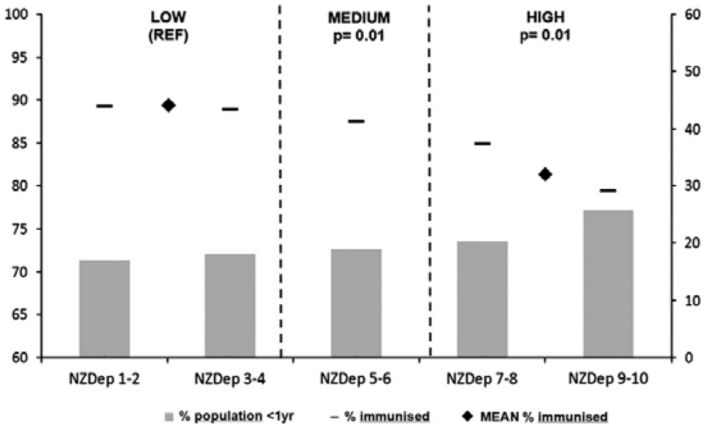

Fig. 2. Proportion of fully immunised children aged 12-months, National; the left y-axis describes immunisation uptake level, the right y-axis population proportions of 12-month-old children.

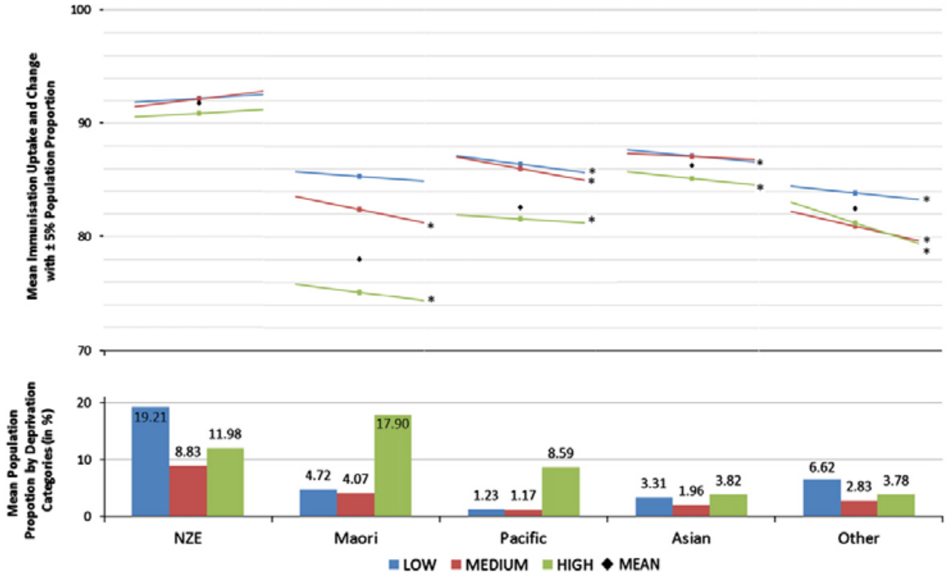

Fig. 3. Mean immunisation uptake by ethnicity, deprivation and the effect of the underlying population distribution; *Stat. significant ($p < 0.01$).

was among Asian children with 86.3% (85.7; 86.9). Both mean rates were above the national average of 85.4% (85.2; 85.6) fully immunised eligible children. Māori (NZ indigenous) presented the lowest coverage levels for children aged 12-months with 78.1% (77.7; 78.4), followed by the Pacific population (ethnic origins from the Pacific Islands including Samoa, Cook Islands, Tonga, Niue, Fiji, Tokelau, and Tuvalu) and 'Other' ethnic group which showed uptake rates of 82.6% (82.1; 83.2) and 82.5% (82.0; 83.0), respectively. Overall, 16 percentage points lower uptake between populations with the highest and lowest mean immunisation rates is found (NZE versus Māori) (Fig. 3).

Stratification by ethnicity and deprivation showed that the NZE population had more than 90% (90.5; 92.5) fully immunized children across all deprivation categories and marginal intra-group variations (i.e. 'low' vs. 'high') (Fig. 3). Uptake rates for all other ethnicities were significantly different compared to the reference category 'NZE, low' ($p < 0.01$) (Table A2). Asian children showed an above average, yet still approximately 6 percentage points lower mean immunisation uptake compared to the NZE population, while demonstrating similar intra-group differences. Māori and Pacific Peoples presented most distinct negative gradients across the deprivation categories with a more than 10% uptake difference between children living in 'low' and 'high' deprivation areas (see Fig. 3).

Pacific children showed similar uptake rates compared to the Asian population in the 'low' and 'medium' deprivation categories; however, compared to the Māori population similar but less pronounced differences between 'low' and 'high' deprivation categories persisted, adversely affecting the mean immunisation uptake for Pacific children (see Fig. 3). The 'Other' ethnic group constitutes all other ethnicities living in New Zealand such as African, Middle Eastern, South American and other ethnicities in addition to a proportion of New Zealand Europeans who identified themselves as 'New Zealanders' or 'Kiwis' at the 2006 census (Goodyear, 2009). This group demonstrated the lowest uptake rates for the low and high deprivation categories of all ethnicities with 83.9% (83.2; 84.6) and 81.0% (79.8; 82.1), respectively. Children living in 'high' deprivation areas had slightly higher uptake compared to the 'medium' deprivation category.

The trend of immunisation uptake was calculated based on the regression estimates (see Table A2) considering a positive and negative change of 5% in population proportion around the mean. An example is provided in the A.1. Among all ethnic groups, New Zealand Europeans (NZE) presented positive trend patterns across the DHBs in immunisation uptake for all deprivation categories with uptake rates ranging from 90.1% to 93.8% around the mean in the respective deprivation categories taking the underlying population proportion into account (Fig. 3). An increase in the population proportion for this ethnicity results in increased uptake rates. By contrast, the remaining ethnic groups consistently showed negative uptake trends in relation to the underlying population distribution in the respective deprivation categories and were furthermore significantly different compared to the reference category (NZE, 'low'; $\alpha = 0.01$; see Table A2).

4. Discussion

Immunisation uptake rates were calculated controlling for ethnicity (Māori, Pacific, Asian, New Zealand European and 'Other') and deprivation to investigate additional variations in coverage levels. At the national level, an inverse association was found between uptake and higher deprivation status. This pattern has been widely documented in the international literature (e.g. Lynch, 1995; Wright and Polack, 2006; Blakely et al., 2007; Wooten et al., 2007). This study found that immunisation uptake is controlled for both ethnicity and deprivation remained significant determinants of low immunisation coverage. In addition, when we considered the District Health Board (DHB) population distributions by ethnic group or deprivation, the effect of ethnicity was even more pronounced, particularly for Māori and 'Other' ethnicities across all deprivation categories, and for Pacific children living in the most deprived areas.

Our deprivation-related findings are consistent with a study on practice immunisation target achievements and patient population characteristics in the Greater Glasgow Health Board, Scotland, although this study did not consider ethnic backgrounds (Lynch, 1995). The lower coverage rates we found among Māori, Pacific and 'Other' ethnic groups is likely to affect a DHB's ability to attain both sufficient overall coverage levels and reduced inequalities in uptake, especially when a DHB has a high proportion of the more vulnerable ethnic groups living in severely disadvantaged communities (e.g. Wright and Polack, 2006; Wooten et al., 2007). This was the first attempt in New Zealand to investigate spatial distribution and disparities in immunisation uptake using the NIR. Previous immunisation studies were typically limited to small sample sizes and as a result were prone to unreliable estimates (e.g. Rainger et al., 1998; Ministry of Health, 2007). We found persistent disparities in immunisation uptake remained for Māori, despite a number of health policy strategies designed to reduce ethnic health inequalities, such as the implementation of the National Immunisation Register (NIR) and a stronger population-based health care system (King, 2000; Grant et al., 2009). We contend that in addition to socio-cultural issues, risk factors such as households with single parents and/or large household sizes continue for Māori to act as substantial barriers to immunisation uptake, especially for families living in more extreme deprivation circumstances (Mueller, 2010). The inequity in immunisation uptake by the 'Other' ethnic group is striking and it appears that this population group has been so far overlooked as a significant contributor to low immunisation uptake in New Zealand (Ministry of Health, 2007, cf.), despite being the third largest ethnic group in New Zealand in addition to being heterogeneous in origin.

In New Zealand the low coverage levels we found in 2007–2009 may be related to insufficient funding currently available for immunisation programmes, which acts as financial barriers for General Practices to provide efficient services (Turner et al., 2009). Lack of funding affects cost-intensive activities such as recall and reminder services to reach parents who do not attend the practice on time (Petousis-Harris et al., 2005; Petousis-Harris and Turner, 2009). Populations which consist of predominantly Māori, Pacific, and Other ethnicities are more likely to demonstrate insufficient immunisation uptake and therefore require more intensive services (e.g. recall/reminders) to improve coverage levels. DHBs with lower proportions of these population groups can devote proportionally more resources to the most deprived and thus enable strategies to reduce inequalities. Based on these findings the authors would recommend that DHBs with higher rates of Māori, Pacific, and 'Other' ethnicities particularly combined with higher population numbers in more socio-economic deprivation are likely to need greater resourcing and attention to services. Nevertheless, it is important to note that immunisation rates have improved in recent times. In July 2009, the New Zealand Government set a health target of 95% immunisation coverage at the DHB level (Ministry of Health, 2009), and consequently complete immunisation (including Prevenar vaccinations for pneumococcal disease) has increased for 12-month-old children from 85% in 2010 to 89% in 2011 (Ministry of Health, 2011).

A strength of this study is the high level of confidence of the coverage estimates on the national scale and with some restrictions on the DHB level (i.e. stratified only by ethnicity or deprivation) due to the large sample size which is enabled by the automated immunisation reporting through the integrated linkage of the register with the Practice Management System. Despite the availability of the NIR database, DHB analyses do not tend to provide statistical significance when controlling for both ethnicity and deprivation status which is likely due to the overall low population numbers in New Zealand. This study has some limitations due to the omission of the voluntary opt-outs (4%) resulting in probable overestimation of coverage. Reasons for opting-out (i.e. non-compliance and/or privacy concerns) were unknown and were not able to be assigned a definite status. A further 10% of children in the NIR were omitted because of missing spatial and/or demographic data. Therefore we are unable to comment on the extent to which insufficient coverage levels at the DHB level may be associated with problems of data management and concerns about the quality of the recording on to the NIR from Practice Management Systems in General Practices.

Further research should focus more specifically on the socio-economic and demographic characteristics of the at-risk ethnic and deprivation groups in order to identify more efficient interventions to increase compliance. To further understand the reasons behind declines for immunisation and potentially develop more specific (risk) communication strategies, future research could investigate the underlying socio-economic and demographic characteristics of the voluntary opt-outs (e.g. Petousis-Harris et al., 2002). Additional research is needed that focuses on investigating the developments in immunisation coverage and identify changes in DHB coverage performance across New Zealand (cf. Wright and Polack, 2006). Time-series analyses for birth cohorts of children aged 24 months should be feasible this year and will facilitate further analyses of disparities in immunisation, in terms of timeliness and the Ministry of Health's milestone of 95% fully immunised at 24 months (2 years).

5. Conclusion

The use of NIR data provided an unprecedented opportunity to examine coverage levels for entire birth cohorts and at various geographical scales. This study has shown that the NIR can be used to focus on the key disparities in immunisation coverage. In particular, our results suggest that intervention strategies to improve coverage should focus on the identified at-risk groups (Māori, 'Other'; Pacific), and devise strategies that are relevant to these population groups.

Acknowledgments

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Table A1
Immunisation coverage 2007–2009.

DHB	% immunised	CI (95%)
New Zealand	85.4	(85.2; 85.6)
South Canterbury	94.2	(93.1; 95.3)
Otago	94.1	(93.5; 94.7)
Southland	93.2	(92.4; 93.9)
Capital and Coast	91.5	(91.0; 92.0)
Wairarapa	90.9	(89.5; 92.3)
Nelson Marlborough	89.9	(88.9; 90.8)
Whanganui	89.7	(88.5; 90.9)
Hutt Valley	89.7	(88.9; 90.4)
Hawkes Bay	89.6	(88.9; 90.4)
Taranaki	89.2	(88.2; 90.1)
Canterbury	87.4	(86.9; 87.9)
Waitemata	87.2	(86.7; 87.7)
West Coast	84.0	(81.9; 86.1)
MidCentral	83.0	(82.0; 83.9)
Auckland	82.8	(82.2; 83.4)
Waikato	82.7	(82.1; 83.3)
Counties Manukau	80.3	(79.8; 80.9)
Tairawhiti	80.1	(78.5; 81.8)
Bay of Plenty	79.9	(78.9; 80.8)
Northland	76.6	(75.5; 77.7)
Lakes	74.0	(72.7; 75.3)

Table A2
The effect of the interaction of deprivation, ethnicity and the population proportion in the respective categories on the mean immunisation uptake across all DHBs.

Mean uptake	Variable			Estimate exp(β)	95%CL (exp(*Lo*; *Up*))
			β_0	89.3	(86.0; 92.7)
	PopProp[a]		β_1	1.001	(1.000; 1.002)
	Dep*Ethn*PopProp				
85.2	High	Asian	β_{11}	**0.998**	**(0.997; 0.999)**
75.9	High	Māori	β_{12}	**0.997**	**(0.996; 0.998)**
83.1	High	Other	β_{13}	**0.995**	**(0.994; 0.996)**
82.0	High	Pacific	β_{14}	**0.998**	**(0.998; 0.999)**
90.6	High	NZE	β_{15}	0.999	(0.999; 1.001)
87.1	Medium	Asian	β_{21}	0.999	(0.997; 1.000)
82.4	Medium	Māori	β_{22}	**0.996**	**(0.994; 0.999)**
81.0	Medium	Other	β_{23}	**0.996**	**(0.994; 0.998)**
86.0	Medium	Pacific	β_{24}	**0.997**	**(0.995; 0.999)**
92.1	Medium	NZE	β_{25}	1.001	(0.999; 1.002)
87.1	Low	Asian	β_{31}	**0.998**	**(0.997; 0.999)**
85.3	Low	Māori	β_{32}	0.998	(0.997; 1.000)
83.9	Low	Other	β_{33}	**0.998**	**(0.997; 0.999)**
86.4	Low	Pacific	β_{34}	0.998	(0.995; 1.000)
92.2	Low	NZE	β_{35}	**REF**	**REF**

All statistical analysis in bold are based on a defined significance level of $\alpha=0.01$; see data and methods section.

[a] DHB Population proportion (PopProp) in the respective deprivation and ethnic category.

Appendix A

A.1. Example of trend calculation

With regard to the regression formula presented in the Data & Methods section the trend shown in Fig. 3 were calculated using regression estimates presented in Table A2. A positive and negative change of 5% of the mean population proportion in each deprivation and ethnicity category was used to determine the change in mean immunisation uptake for the respective deprivation and ethnicity category. For example, considering Māori classified as medium deprivated the effect β_{22} was added to the overall effect β_1, so that $\exp(\beta_1+\beta_{22})$ represents a change in mean immunisation uptake for 1% change in population proportion. Subsequently, in this category, the change in mean immunisation uptake for a 5% change in population proportion was calculated as mean uptake $\pm\exp(\beta_1+\beta_{22})^5$.

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Immunization in the Print Media - Perspectives Presented by the Press

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Immunization in the Print Media—Perspectives Presented by the Press

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New Zealand (NZ) has low immunization coverage for a Western country. Media coverage, including views and content expressed on editorial pages, can affect immunization uptake both positively and negatively. The objectives of this research were to analyze the content of written media in 2001 and 2003 throughout NZ in terms of vaccination and vaccine preventable diseases from a supporting, neutral, or opposing perspective; how vaccination and vaccine-preventable diseases are presented to their target audiences; and changes over time with possible influences on these changes. Print media clippings were analyzed from 400 national publications in 2001 and 2003 for references to immunization and vaccine-preventable diseases. Articles were coded as supportive, neutral, or opposing immunization. During two 12-month periods, 2,113 articles, including letters to the editor and opinion columns were analyzed: 1,228 from 2001; and 885 from 2003. Thirty-three percent (704) were classified as "supportive," 17% (362) as "opposing," and 51% (1,081) as "neutral." Articles and perspectives in the media opposed to immunization were significantly more plentiful in 2001 than in 2003 (328/1,228; 27% vs. 34/885; 4% of all immunization media; $\chi^2 = 189.46$; $p = <0.0001$; $df = 1$)*. References to specific vaccines and disease were examined. During this study period there were high-profile infectious disease and vaccine issues that may have shaped the differences observed in the media clippings. This study indicates an overall positive trend toward reduction in alarmist anti-immunization messages in media. Strategies implemented by the Immunization Advisory Centre to counter misinformation may have contributed to reduction in anti-immunization messages.*

The economic and societal costs of vaccine preventable disease are well documented. For example, in the United States, every dollar spent to purchase measles-containing vaccine saved $10.30 in direct medical costs and $3.20 in indirect societal costs (Public Health Agency of Canada, 1999). Dramatic declines in morbidity in NZ have been reported for the nine vaccine-preventable diseases for which vaccination is universally recommended for children. For example, as a direct result of immunization, NZ has been free of poliomyelitis for many decades.

New Zealand, however, has a sustained low immunization coverage rate. Most recent data indicate that fewer than 65% of NZ children are fully immunized at 2 years (Ministry of Health, 1992; North Health, 1996; Turner, Baker, Carr, & Mansoor, 2000). The resultant high disease rates of illnesses such as measles and

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whooping cough place unnecessary financial burden on health resources (Grant et al., 2003). New Zealand now has a greater pertussis (whooping cough) disease burden than most other developed countries. Based on two decades of comparisons of *Bordetella pertussis* rates, NZ has had between five and 10 times as much pertussis as either the United Kingdom or the United States (Blakely, Mansoor, & Baker, 1999; Farizo et al., 1992; Guris et al., 1999; Reid & Graham Smith, 1984; Van Buynder et al., 1999).

Many factors contribute to reaching and maintaining high vaccine coverage. Success requires multifaceted approaches (Lister, McIntyre, Burgess, & O'Brien, 1999). Ultimately, it is the combined behavior of health professionals, parents, caregivers, and the wider community who determine the success of a childhood immunization program. This behavior is shaped by a number of environmental factors such as policy and legislation (Lawrence, MacIntyre, Hull, & McIntyre, 2004), education (Wroe, Turner, & Salkovskis, 2004), socioeconomic conditions (Ministry of Health, 1992), and by mass communication (Gangarosa et al., 1998).

Media activities can directly affect immunization uptake both positively and negatively (Danovaro-Holliday, Wood, & Le Baron, 2002). A recent Cochrane review concluded that mass media should be considered a tool that may encourage use of effective health services and discourage those of unproven effectiveness (Grilli, Ramsay, & Minozzi, 2005). The reach of the combined mainstream print media in NZ is wide, covering all homes in all regions at least once per week (including free regional newspapers), although they may not be read in every home. Media reports questioning vaccine safety may significantly increase parental concern (Mansoor, Sarfati, & Durham, 1998). Such media reporting often increases as disease prevalence declines and the focus changes from fear of disease to fear of vaccine safety (Leask, 2002).

In Wales there was extensive adverse coverage of the measles, mumps, rubella (MMR) vaccine in one local newspaper from June to September in 1997. Following this period there was a 13.6% decline in vaccine uptake in the distribution area of that publication, compared with a decline of only 2.4% elsewhere (Mason & Donnelly, 2000), illustrating the power of one local newspaper to influence the perceptions of a community. A challenge for national health organizations is therefore to respond to local and grassroots media campaigns opposing immunization. A possible strategy is a nationwide network of contacts within each region that monitors local immunization media coverage and provides responses to issues raised by local lobby groups opposed to immunization.

The objectives of our research were to analyze the content of written media reports (magazines and newspapers) in 2001 and 2003 throughout NZ with respect to the focus in terms of vaccination and vaccine-preventable diseases from a supporting, neutral, or opposing perspective. We also how vaccination and vaccine-preventable diseases are presented to their target audiences, what changes occur over time, and what are the possible influences on these changes.

Methods

The study analyzed NZ print media clippings from 400 different national publications for the years 2001 and 2003. The years were chosen because 2001 contained some important changes to the NZ immunization schedule and 2003 was the year the study was undertaken. These were obtained from a professional clipping agency

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that inspects all national daily and weekly newspapers and nondaily suburban and provincial papers and magazines, including health-related publications, and provides copies of all articles mentioning the words immunize/immunization, vaccine/vaccinate, and the nine vaccine-preventable diseases in the childhood schedule (poliomyelitis, diphtheria, whooping cough/pertussis, tetanus, hemophilus influenza, Hepatitis B, measles/morbilli, rubella, and mumps). Both data sets contained 12 consecutive months of media clippings. We analyzed articles, including letters to the editor and opinion columns, for their tone and content. While the word "article" is used throughout this study, it should be recognized that this includes letters and columns.

After initial reading of the material, discussions between three of the researchers determined that articles would be coded according to their perspective—whether the article was "supportive," "neutral" (containing only informative information and did not expressing any stance on immunization), or "opposed" to immunization. Articles then were categorized and coded by one researcher and entered in a database. Fields included date, type, and region of media source; the vaccine(s) and disease(s) referred to; mention of disease epidemics or adverse events as a result of vaccines; and the "perspective" code. To assess reliability, 20 randomly selected articles were submitted, along with guidelines of the categorization and coding, to a blinded independent reviewer. Critical assessment and checking confirmed complete agreement.

Some ($n = 26$) articles from the 2003 period had no attached date or source. These were included for analysis of the total sample set, and in analysis of the 2003 time period, but were not included in analysis regarding region, type of media, or date.

Details were entered into an Excel spreadsheet and converted into an Access database for analysis. Queries were made to find links, proportions, and statistics. Epi-Info was used to find p values and to check for the significance of results when making comparisons.

Results

A total of 2,113 articles, including letters to the editor and content expressed on editorial pages, from 12-month periods were included in the analysis: 1,228 from 2001 and 885 from 2003.

Supportive, Neutral, and Opposing Views and Their Thematic Focus

Of these 2,113 clippings, 33% (704) were classified as "supportive," 17% (362) as "opposing," and 51% (1,081) as "neutral."

Although the region of Northland has only 3.7% (140,133) of the national population, 20% of all media opposed to immunization and 13% of immunization media overall originated in this region. This anti-immunization material was attributed to a very small number of authors.

Media opposed to immunization was markedly higher in 2001 than in 2003 (328/1,228; 27% vs. 34/885; 4% of all immunization media; $\chi^2 = 189.46$; $p = < 0.0001$; df $= 1$). Sixty-six percent (240/362) of all these clippings were letters to the editor and expressed the opinion of an individual or organization. These often

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were repeated and circulated through several local newspapers throughout the country. Additionally, these 240 articles were written by the same small group of authors who regularly wrote to newspapers and evoked responses from a wider network of authors from around the country.

Anti-immunization media was dominated by opinion in 2001 (225/338; 67%). In 2003 there was a significant decrease to 44% of all opposing media (15/34; $\chi^2 = 8.26$; $p = < 0.004$; df = 1).

Media opposing immunization was present most often in local (294, 81%) rather than national publications (9, 2.5%; $\chi^2 = 461/00$; $p = < 0.0001$; df = 1). Anti-immunization media was markedly lower, although not absent, in medical publications (7/117; 6%). Articles mentioning Māori or Pacific People also had a low number of opposing views toward immunization (9/112, 8%) compared with the 17% anti-immunization articles across the whole sample ($\chi^2 = 5.72$; $p = < 0.0168$; df = 1).

Anti-immunization media regarding the MMR vaccine was more prominent in 2001 than in 2003, with 201 articles in 2001 but only 12 in 2003 ($\chi^2 = 110.39$; $p = < 0.0001$; df = 1). Influenza and meningococcal vaccines also were commonly mentioned vaccines among anti-immunization media. These were both more commonly mentioned in 2001 than in 2003 following the same pattern of decrease as the MMR vaccine.

Articles Mentioning Adverse Events Following Immunization and Their Stance Toward Immunization

Adverse events to vaccines were referred to in 501 articles. Of the total 362 articles, which were classified as media opposing immunization, 264 articles (73%) mentioned adverse events, with 179 of these concerned with adverse events to the MMR vaccine. The influenza vaccine and the diphtheria, tetanus and acellular pertussis (DTaP) vaccines also commonly were mentioned with regard to adverse events in anti-immunization media. In 44 anti-immunization articles (69% of "anti-immunization" material), adverse events were mentioned without mentioning a vaccine. In these articles adverse events often were described using emotive language and described tragic personal stories. Very seldom were they backed up by scientific evidence; more often they were accompanied by anecdotal support.

Media Supportive of Immunization

Media supportive of immunization contributed to 33% (704/2,113) of total media for the sample period. This proportion stayed consistent between 2001 (35%) and 2003 (31%, $\chi^2 = 2.49$; $p = < 0.1147$; df = 1), thus the proportion of proimmunization was significantly higher than that of anti-immunization media in the total sample period (33% vs. 17%; $\chi^2 = 146.74$; $p = < 0.0001$; df = 1). Most of this media was present in informative rather than in opinion-based articles in both 2001 and 2003. This contrasted with the anti-immunization media, which were mostly in opinion-based sources such as letters to the editor, viewpoints, and editorials.

Supportive media was under-represented in letters to the editor (98/387, 25%), which were dominated by anti-immunization items (222/387, 57%) and did not follow the overall trend of having more pro- than anti-immunization media. There was a decrease in proimmunization media in the national newspapers from 33% in 2001

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to only 9% in 2003. This was a substantial decrease ($\chi^2 = 17.4$; $p = < 0.0001$; df $= 1$), shifting to neutral presentations in 2003. Medical publications and articles mentioning Māori or Pacific People appeared to have higher proportions of proimmunization media than the overall trend.

Changes Over Time: Differences in Focus Between 2001 and 2003

The diseases and vaccines in focus were different for each year. MMR was mentioned in 23% (480) of all articles in the total sample period. The majority of these were in 2001, where 444 articles mentioned MMR compared with only 36 in 2003. Measles disease followed the same pattern and was mentioned in 17% of all articles in the sample period: 332 articles in 2001 and only 33 in 2003. In 2001, MMR was almost equally associated with proimmunization and anti-immunization media. This changed in 2003, when the proportion of anti-immunization media decreased (and the proportion of proimmunization media increased significantly).

Pertussis was a common disease concern in 2001 and 2003, appearing in 10% of all disease concern articles for both periods. Overall, the media surrounding DTaP and pertussis was more often proimmunization than anti-immunization. There appeared to be a higher proportion of anti-immunization media regarding the vaccine in 2001 than in 2003 (23% vs 10%), but this was not highly significant ($\chi^2 = 3.36$; $p = < 0.067$; df $= 1$).

Discussion

Articles and perspectives in the media opposed to immunization were significantly higher in 2001 than 2003. There are a number of possible reasons for this. The majority (73%) of anti-immunization media tended to focus on adverse events, tended to be found in letters to the editor, made emotive appeal and cited tragic personal stories, and did not tend to refer to specific vaccines, with the exception of MMR in 2001. Waning media and public interest in MMR may explain this decrease. In contrast, proimmunization media tended to be informative rather than opinion based and was found in a greater proportion of Maori (indigenous) and Pacific populations (two important ethnic minorities in NZ society). Although both pro- and anti-immunization articles mentioned pertussis and MMR vaccines in 2001 and 2003, there was a trend (of limited statistical significance) toward more articles supportive of these vaccines in 2003 as opposed to in 2001.

Perhaps the phenomenon that poses the greatest growing threat to controlling vaccine preventable diseases is the ability of the disparate groups of the anti-immunization movement to communicate increasingly more widely and rapidly through the growth of the Internet and other mass media. This serves to amplify their influence beyond justification. These groups and the doubts they generate in the minds of both caregivers and health professionals are becoming a major issue for vaccine providers such as family physicians (Petousis-Harris, Goodyear-Smith, Turner, & Soe, 2004). The public health consequences of these media activities can be dramatic. Where there is either mass promotion or scaremongering, immunization coverage is affected accordingly (Gangarosa et al., 1998). For example, the effects of anti-immunization movements on pertussis epidemics in several countries have been well documented. In countries where vaccination had been interrupted by anti-immunization

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movements and negative press, there have been outbreaks of pertussis (Gangarosa et al., 1998).

Low immunization rates have been attributed partly to a decline in disease rates, serving as a lack of reminder to parents to immunize their children (Leask 2002). Parents may have little knowledge of the disease or the vaccine and be swayed easily by anti-immunization messages in the media. NZ research has identified that parental knowledge of vaccination and the diseases that vaccines protect against is an important determinant in the decision to vaccinate their child (Petousis-Harris, Goodyear-Smith, Godinet, & Turner, 2002; Petousis-Harris, Turner, & Kerse, 2002; Wroe et al., 2004). Additionally, a study of NZ mothers' attitudes toward immunization suggested that fear of adverse events was a common theme amongst those parents who chose not to vaccinate their children (Petousis-Harris et al., 2002). The large number of anti-immunization articles that mentioned adverse events in 2001 may have contributed to such anxiety about adverse events associated with immunization.

In NZ there have been recent initiatives to promote vaccination as an effective way to prevent infectious disease in the print media. For example, the University of Auckland runs a communication strategy called the Immunization Advisory Centre (IMAC), developed progressively over the past 6 years, that implements both proactive and reactive strategies to deal with the media's coverage of disease and immunization. Proactive strategies include a communications team who builds relationships between experts within IMAC and the media, and contributes to articles around vaccine-preventable diseases (e.g., yearly articles about influenza immunization at the beginning of the annual influenza immunization campaigns). Reactive strategies include sending rebuttals addressing key letters to the editor that express anti-immunization sentiment and being involved in televised debates on immunization. In June 2002 the Ministry of Health Director of Public Health, Dr. Colin Tukuitonga, issued a directive to health professionals to cease handing out anti-immunization material to expectant mothers because it could endanger the health of babies. The resulting media attention gave rise to increased public and professional awareness about immunization issues and misconceptions (Topham-Kindley, 2003).

As noted in the literature, the media have a significant effect on public perception of disease and vaccination, ultimately leading to changes in vaccine coverage. During this study period there were high-profile infectious disease and vaccine issues that may have shaped the differences observed in the media clippings.

Vaccine Awareness Issues

MMR

A school mass immunization program for MMR was launched in 2001 in an attempt to prevent a predicted epidemic. A media campaign was started in June 2001, with immunization beginning in schools in July. This ran throughout the year in schools nationwide and appeared to spark a high number of articles on both the MMR vaccine and measles as a disease.

The source of the controversy surrounding the MMR vaccine's alleged link to autism and Crohn's disease was published in 1998 (Wakefield et al., 1998). References to this continued to appear in the media in 2001. A high proportion of letters to the editor and a substantial proportion of informative articles included this

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research as a reference in anti-immunization articles, although any causal relationship between MMR and autism or Cohn's disease repeatedly has been disproved (Institute of Medicine, 2001; Makela, Nuorti, & Peltola, 2002). By 2003 reporting had dropped away.

Schedule Change for Polio, Pertussis, Diphtheria, and Tetanus Vaccines

A planned change to the national immunization schedule in February 2002 and announced in 2001 affected the timing and delivery of the childhood vaccines. Furthermore, there was a rapid change in formulation of the DTP vaccine in August 2001, quite precipitously owing to vaccine supply problems.

Pertussis Epidemic

The pertussis epidemic of 1999–2001 peaked at the end of 2000/beginning of 2001. The clippings for 2001 were taken during this epidemic and contain high media coverage of pertussis. Initiatives to increase pertussis awareness were part of a national well-child campaign in 2001 and promotion occurred throughout the next 2 years. This is reflected in the media, with a high coverage of pertussis and a high number of disease concern articles in both 2001 and 2003. A graphic pertussis television advertisement, which screened in 2001, also may have contributed to media coverage of the disease.

This study indicates overall a positive trend toward reduction in alarmist anti-immunization messages in NZ media. Strategies by bodies such as IMAC and the Ministry of Health may have contributed to this improvement, although the lack of national immunization coverage data for 2001–2003 and the absence of research into current parental attitudes on immunization (in 2003) makes it difficult to verify this. Further research into possible changes in parental attitude toward immunization during this time also would provide helpful information about the success of such organizations' media strategies.

The decrease in MMR and measles in the media appeared to be correlated with the decrease in the letters to the editor and anti-immunization media, as a high proportion of each of these was about MMR. The international decline in the concerns around autism and Crohn's disease over this time may be a major reason for this.

An Australian study showed that only 4.7% of media opposed immunization (Leask, 1998), while our study found 27% of print-media coverage was anti-immunization in 2001. This had reduced to a similar rate as Australia (4%) in 2003.

It is of interest that the style of anti-immunization media has shifted from less opinion-style to more information-style articles in 2003. Whether this is a reflection on a deliberately different angle from this lobby, or just a change in the main players, is unclear. The opposing media clearly is dominated by very few active proponents. The main target of the lobby is the topic of vaccine events. It is salient to note that overall two out of three articles around vaccine events did not highlight any specific vaccine but generalized events to all vaccines.

Limitations of this study include its restricted scope to print media, given the wider accessibility to the NZ population of television and radio, as well as the lack of national immunization coverage data available at the time the study was undertaken to provide any quantitative estimation of the effect of the communications

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media content and focus on demand for immunization. Quantitative findings have not clearly elucidated distinctions among anti-immunization media, media supportive of immunization, and media neutral in stance toward immunization.

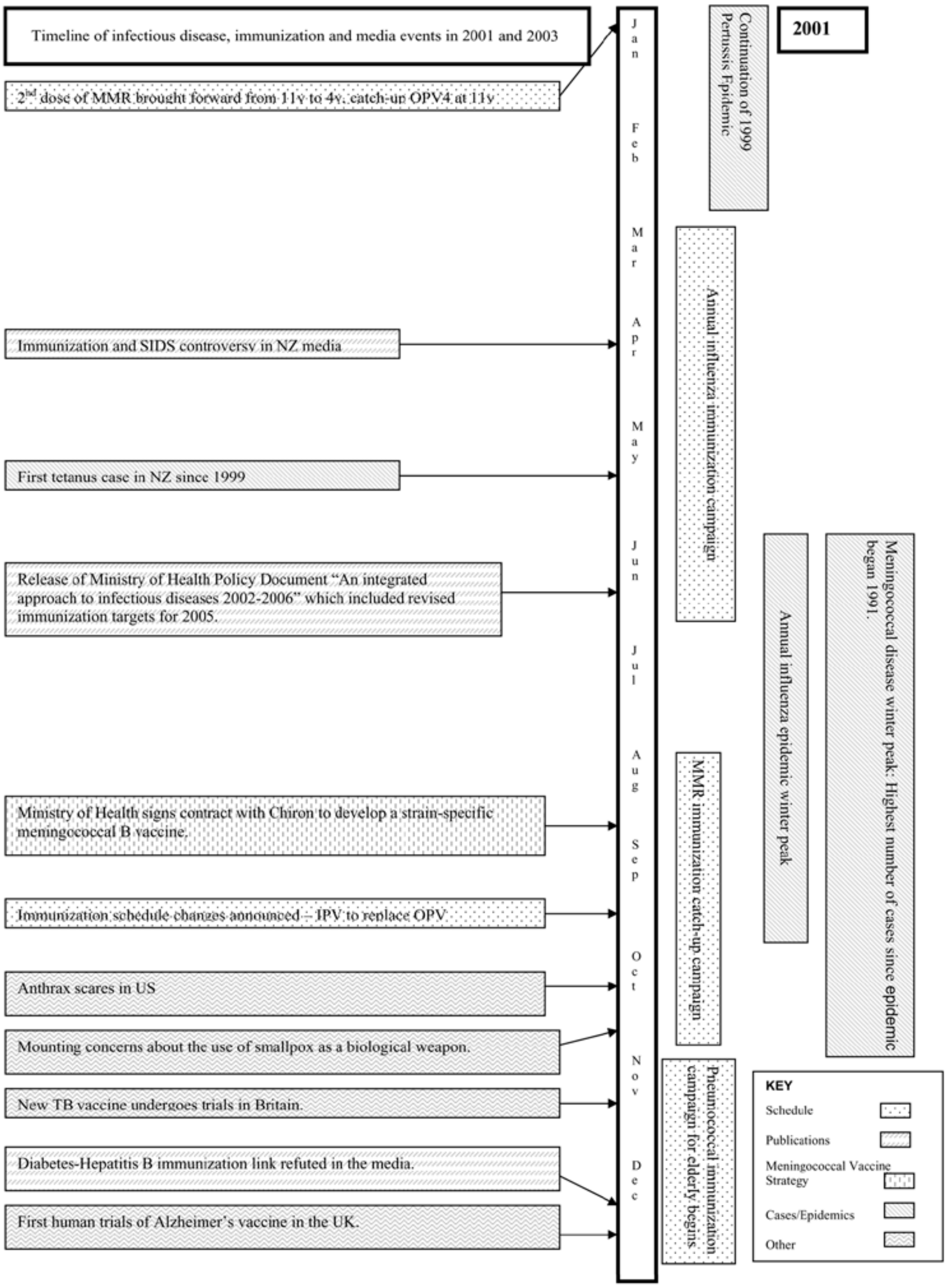
Timeline of infectious disease, immunization and media events in 2001 and 2003
2nd dose of MMR brought forward from 11y to 4y, catch-up OPV4 at 11y
Immunization and SIDS controversy in NZ media
First tetanus case in NZ since 1999
Release of Ministry of Health Policy Document "An integrated approach to infectious diseases 2002-2006" which included revised immunization targets for 2005.
Ministry of Health signs contract with Chiron to develop a strain-specific meningococcal B vaccine.
Immunization schedule changes announced – IPV to replace OPV
Anthrax scares in US
Mounting concerns about the use of smallpox as a biological weapon.
New TB vaccine undergoes trials in Britain.
Diabetes-Hepatitis B immunization link refuted in the media.
First human trials of Alzheimer's vaccine in the UK.
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Continuation of 1999 Pertussis Epidemic
2001
Annual influenza immunization campaign
Annual influenza epidemic winter peak
Meningococcal disease winter peak: Highest number of cases since epidemic began 1991
MMR immunization catch-up campaign
Pneumococcal immunization campaign for elderly begins
KEY
Schedule
Publications
Meningococcal Vaccine Strategy
Cases/Epidemics
Other

Figure 1. Timeline of infectious disease, immunization and media events in 2001 and 2003.

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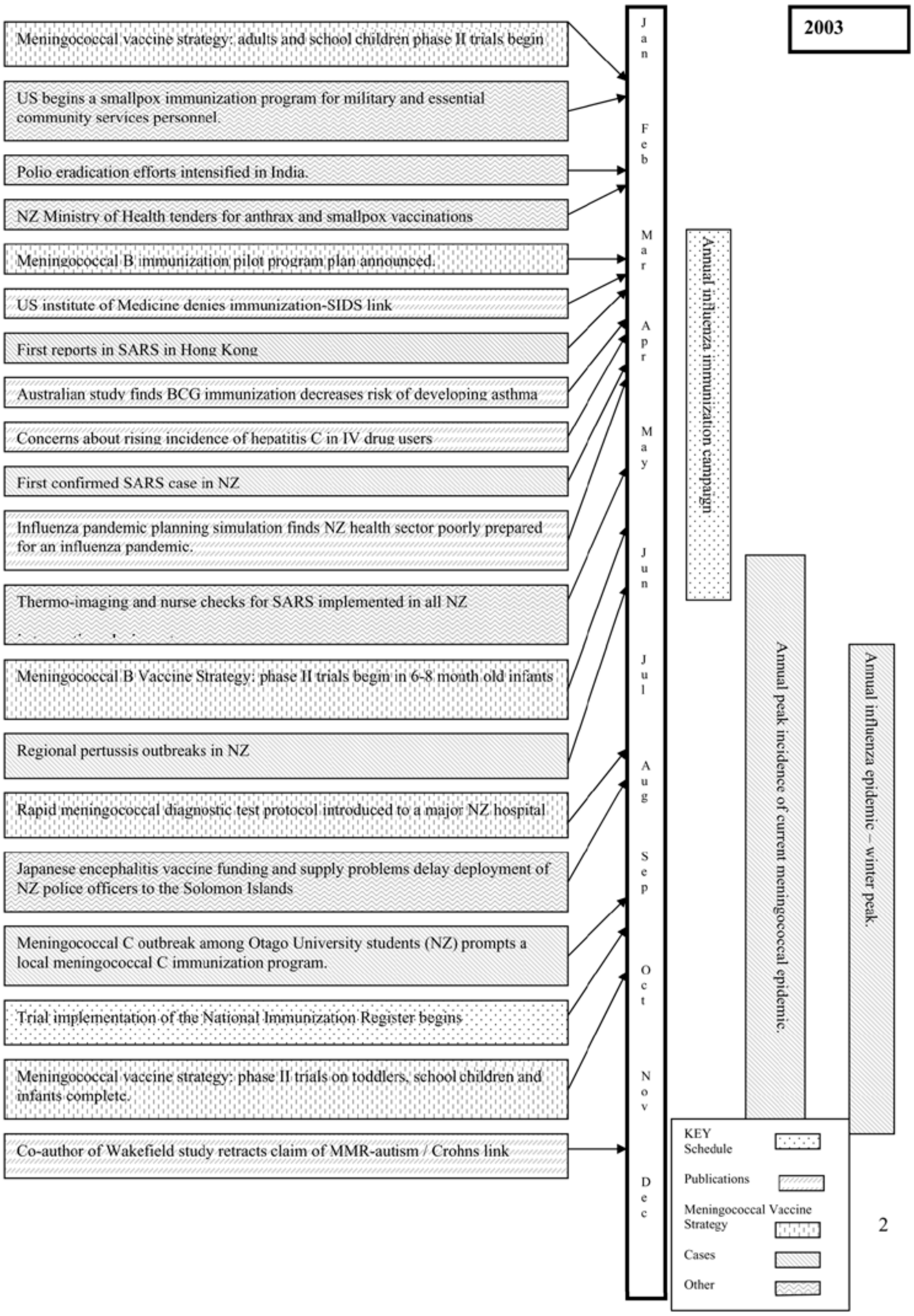
2003
Meningococcal vaccine strategy: adults and school children phase II trials begin
US begins a smallpox immunization program for military and essential community services personnel.
Polio eradication efforts intensified in India.
NZ Ministry of Health tenders for anthrax and smallpox vaccinations
Meningococcal B immunization pilot program plan announced.
US institute of Medicine denies immunization-SIDS link
First reports in SARS in Hong Kong
Australian study finds BCG immunization decreases risk of developing asthma
Concerns about rising incidence of hepatitis C in IV drug users
First confirmed SARS case in NZ
Influenza pandemic planning simulation finds NZ health sector poorly prepared for an influenza pandemic.
Thermo-imaging and nurse checks for SARS implemented in all NZ
Meningococcal B Vaccine Strategy: phase II trials begin in 6-8 month old infants
Regional pertussis outbreaks in NZ
Rapid meningococcal diagnostic test protocol introduced to a major NZ hospital
Japanese encephalitis vaccine funding and supply problems delay deployment of NZ police officers to the Solomon Islands
Meningococcal C outbreak among Otago University students (NZ) prompts a local meningococcal C immunization program.
Trial implementation of the National Immunization Register begins
Meningococcal vaccine strategy: phase II trials on toddlers, school children and infants complete.
Co-author of Wakefield study retracts claim of MMR-autism / Crohns link
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Annual influenza immunization campaign
Annual peak incidence of current meningococcal epidemic.
Annual influenza epidemic – winter peak.
KEY
Schedule
Publications
Meningococcal Vaccine Strategy
Cases
Other
2

Figure 1. Continued

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Further studies using quantitative methods to examine article discourse may provide clearer information on these distinctions.

Implications

To maintain public confidence, health planners constantly need to develop and review their health promotional messages and relationships with the media. Raising awareness of infectious diseases may be helpful in shifting the emphasis away from vaccine safety concerns. Effective responses to anti-immunization messages also may be important, and consideration needs to be applied to appropriate strategies. As observed by Leask (2002), anti-immunization claims frequently are introduced by health professionals attempting to refute them, risking amplification of public awareness of anti-immunization arguments. It was suggested that health professionals not respond defensively by repeating the anti-immunization arguments. Within that article there are examples of responding effectively to anti-immunization sentiment without inadvertently furthering its cause. For example, given that anti-vaccination articles use emotive language and tragic personal story, a possible strategy for promoting immunization may involve equally tragic accounts of those who contract vaccine-preventable diseases.

This study indicates a large proportion of letters to the editor is from individuals opposed to immunization. A possible strategy for immunization promotion may include increasing the proportion of letters to the editor supportive of immunization, including both rebuttals to articles and letters opposing immunization as well as letters supportive of immunization in response to articles written with a "neutral" stance toward immunization.

Whether the reduction in anti-immunization messages is sustainable in an environment where little disease is present or relies on reminders of disease remains to be seen. If there is little media attention to vaccine-preventable diseases, the general fear of alleged vaccine events appears to become more prominent.

The media strategies that have been built over the past few years in NZ by IMAC and the Ministry of Health to deal with the media include providing them with a few key accessible, media trained personnel who can talk on a wide range of immunization issues. All issues posed by the media are taken seriously and responded to immediately. Local journalists have come to know these key people and use them as a first point of contact when any new issues arise. Several front-page alarmist negative stories such as results of a dubious study on the relationship between MMR vaccine and autism (Geier & Geier, 2003) were prevented by this strategy when journalists allowed the key personnel to follow up rapidly on the new information prior to going to press. Strategies such as this have been recommended during a workshop in vaccination and risk communication in Virginia (Leask, 2002), highlighting the importance of meeting the needs of the media. These strategies may have contributed to the significant decrease in media coverage, in particular negative, between 2001 and 2003.

While there is a financial cost to vaccinating vulnerable populations against preventable disease, the resulting reduction in morbidity and mortality has overwhelming financial and human welfare gains. To achieve adequate immunization coverage rates, it is important that the population, both the public and health professionals, have confidence in the safety of vaccines and appreciate the importance of providing

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prevention against these diseases. The print media plays an important role in public awareness and education with respect to these issues.

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Fact or fallacy? Immunisation arguments in the New Zealand print media

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Abstract

Objective: To explore New Zealand's four major daily newspapers' coverage of immunisation with regards to errors of fact and fallacy in construction of immunisation-related arguments.

Methods: All articles from 2002 to 2007 were assessed for errors of fact and logic. Fact was defined as that which was supported by the most current evidence-based medical literature. Errors of logic were assessed using a classical taxonomy broadly based in Aristotle's classifications.

Results: Numerous errors of both fact and logic were identified, predominantly used by anti-immunisation proponents, but occasionally by health authorities. The proportion of media articles reporting exclusively fact changes over time during the life of a vaccine where new vaccines incur little fallacious reporting and established vaccines generate inaccurate claims. Fallacious arguments can be deconstructed and classified into a classical taxonomy including non sequitur and argumentum ad Hominem.

Conclusion: Most media 'balance' given to immunisation relies on 'he said, she said' arguments using quotes from opposing spokespersons with a failure to verify the scientific validity of both the material and the source.

Implications: Health professionals and media need training so that recognising and critiquing public health arguments becomes accepted practice: Stronger public relations strategies should challenge poor quality articles to journalists' code of ethics and the health sector needs to be proactive in predicting and pre-empting the expected responses to introduction of new public health initiatives such as a new vaccine.

Key words: Mass media, immunisation, vaccination.

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Most people obtain information about health issues from the mass media. When a topic affects most of the population, rather than to a small sector, it becomes relevant to the media, and from a news perspective immediately 'hot'. If one moves from a health topic relevant to a smaller sector such as a new treatment for a rare cancer to one with more universal appeal such as a mass childhood immunisation program then the number of people to whom the story is relevant vastly increases. If one adds personal adventure/mishap, controversy such as two sides that can pit against one another, graphic or emotive images, then immunisation can become an excellent topic for media attention.

Opposition to immunisation

Despite overwhelming evidence supporting the routine use of a number of vaccines, public controversies generated by anti-immunisation proponents regularly arise, gaining media attention and this has been shown to erode vaccine uptake.[1-3] Anti-immunisation rhetoric generally contains errors of fact and/or errors of logic (fallacies).[4,5]

Organised opposition to immunisation has been present since legislation made smallpox vaccination compulsory in 1853.[6,7] The arguments used in opposing vaccination and immunisation programs have remained constant since that time[8] and, apart from the Internet, the avenues for presenting anti-immunisation arguments also have remained relatively unchanged.[8]

Anti-immunisation rhetoric and polemic arguments have been examined and the arguments themselves are well documented.[4,5,9,10] However, these arguments have previously not been examined for fallacies of logic.

Fallacy

A fallacy is a component of an argument that is demonstrably flawed in its logic therefore rendering the line of reasoning invalid. Often this is as a result of a false premise and/or false conclusion. It is useful to identify flawed reasoning in order to enable effective and convincing refutation of errors.

There are various definitions of the term fallacy and ways of classifying certain

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fallacies. Plato was the first philosopher to collect and document examples of flawed reasoning[11] and Aristotle the first to name 13 different types of errors in reasoning or errors in logic.[12] Since Plato and Aristotle, particularly following the Dark Ages, philosophers have contributed further to these works. Today there are various competing and overlapping ways to classify fallacies: The Internet Encyclopaedia of Philosophy lists the 177 most common.[13]

Broadly, fallacies can be classified as formal, where the structure or form is flawed, and informal, where the argument has valid form but the premises are false and therefore cannot support the conclusion.

Place of logic in society

Logic is concerned with the principles of correct reasoning, relying on valid argument rather than emotional appeal in clarifying and directing our judgements. A well-functioning society requires its processes and decisions to be based on logical reasoning which therefore lead to good conclusions.

'He said she said' news formula

'He said she said' reporting is a way to provide balance to a news story without actually evaluating the material or statements for fact or fallacy, or indeed performing any critique.[14] An example of this is the claim that vaccines cause autism. Virtually no mainstream scientist believes that such a link exists, only anti-immunisation protagonists, however, balancing quotes from both sides of the argument give the assertion credibility.

Aim

In order to explore immunisation arguments appearing in the New Zealand (NZ) print media, a content analysis study of the major daily NZ newspapers was conducted with the aim of critically examining the construction of immunisation-related arguments by describing and classifying errors of fact and fallacy.

Method

The Immunisation Advisory Centre (IMAC), at the University of Auckland maintains a database of clippings, accessed from a commercial media watch service, from a variety of print media in which words associated with vaccines and vaccine preventable diseases are mentioned. At the Centre all newspaper articles printed between January 2002 and December 2007 from the daily papers of four major NZ urban centres (*The New Zealand Herald*, *The Press*, *The Dominion Post*, *The Otago Daily Times*) were extracted from the database. The circulation of these papers extends nationally.

Data recorded included origin and date of publication, type of article, title, author, page number and type of vaccine the article addressed. Examples of each type of error of fallacy are presented.

Errors of fact

All articles were assessed for errors of fact – (statements that are false) regarding any comment (whether direct or implied) on vaccine safety, efficacy and/or effectiveness. There are three types of errors of fact: completely erroneous statements that are false (not substantiated by scientific evidence), errors of omission where information is 'cherry-picked' and presents only part of the truth, ignoring data that contradicts the position, and errors of commission, where information is misconstrued, exaggerated or inflated to support a claim.

For the purposes of this study the terms 'fact' and 'truth' have been used to illustrate that which is supported by the vast majority of scientific literature so as to constitute the central theories within vaccinology.

Fact was verified via the peer reviewed evidence-based literature. Comments in newspaper articles supported by the majority of scientific literature were classified as substantiated and coded green. If the scientific literature refuted the comment of interest, the comment was classified as unsubstantiated and coded red.

Based on the overall make-up of its content (the number of lines coded green and red), each article was assigned a substantiation score between one and five, where the number corresponded with one of the content analysis measures (based on Boykoff's content analysis study[15]) below:

1. All statements substantiated.
2. Some statements unsubstantiated.
3. Equal proportions of substantiated and unsubstantiated statements.
4. Most statements unsubstantiated.
5. All statements unsubstantiated.

Table 1: Examples of errors of fact about vaccination efficacy, effectiveness or safety in the New Zealand print media 2002–2007.

Type of error	Example	Comment
Erroneous statement	"But there is evidence it [ADHD] is aggravated by substances that get into the child's body from other sources, such as antibiotics, lead in the environment, possibly vaccination, as well as food." *Auckland GP*, NZ Herald 2006	There is no evidence in the scientific literature that ADHD is aggravated by vaccines.
Error of omission	"Eighty per cent of those given the vaccination in a New Zealand trial had a reaction to the vaccine and no placebo tests were conducted, Mr Peters told Parliament." *The Dominion Post*, 20 October 2004	Almost all of these reactions were minor local injection site reactions. Placebo controlled trials were considered unethical and unnecessary as enough bridging data was available.
Error of commission	""MeNZB vaccination is free and safe" *Otago Daily Times*, 20 June 2005	Vaccination is not always safe – serious adverse events occur on rare occasions

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Descriptive statistics were performed to calculate the frequencies of unsubstantiated claims for various vaccines and for the changes over time. A random selection of 10% of the articles were independently assessed and coded by two other members of the research team, and Kappa analysis was used to test their level of agreement.

Errors of logic

Acknowledging that it is insufficient to merely classify comments as either substantiated or unsubstantiated (to solely assess the substance behind the argument or viewpoint), all the articles were reassessed for errors in logic. These errors were in regard to all views on vaccines, not just those regarding safety, efficacy and effectiveness. An error of logic involves a fault in reasoning, which renders the argument invalid. During the past 2,500 years there have been many additions and alternatives to the early taxonomy proposed by Aristotle and there is no one standard. The authors chose to observe the early, shorter taxonomy to illustrate that modern fallacies may still be described using ancient logic. These were categorised according to the following taxonomy.[12] See Tables 1 and 3, which include the type of error, the quote containing the error, and comment about the error.

Formal errors of logic

The structure is flawed and deduction is invalid:

- *Non-sequitur* (claim purports to show causality)
- *Post hoc ergo propter hoc* (affirming the consequent – assumes a causal relationship because one event follows another in time)
- *Cum hoc ergo propter hoc* (denying the antecedent – assumes a causal relationship because one event occurs at the same time as another)
- *Petitio Principii* (begging the question)
- *Circulus in Probando* (arguing in a circle or assuming the answer)

Informal errors of logic

Have a valid form but false premises that do not support the conclusion:

- *Dicto simplicter ad dictum secundum quid* (fallacy of accident – makes a generalisation that disregards exceptions)
- *Dicto secundum quid ad dictum simpliciter* (reverse accident – argues from a special case to general rule)
- Fallacy of the consequent (draws a conclusion, which the premise does not support)
- Verbal fallacies (uses words in an inappropriate manner, for example emotive language, to make or support a claim)
- False attribution (appeals to irrelevant, unqualified, biased or fabricated source)
- Red herring fallacies (argument given in response to another argument, not addressing the original issue)
- *Ignoration Elenchi* (irrelevant conclusion, diverts attention away from a fact in dispute rather than address it directly)
- *Argumentum ad hominum* (addresses purely personal considerations – shoots the messenger)
- *Argumentum ad verecundiam* (attributes to misleading authority)
- Straw man argument (based on misrepresentation of an opponent's position)
- Fallacious anecdotal evidence (uses personal accounts or experiences in an ambiguous fashion to support a claim).

It should be noted that use of anecdotal evidence sometimes may be valid, when personal accounts or experiences are employed in an illustrative fashion.

This second dataset includes the source of the article, the type of error, the quote containing the error, and the person or organisation to which the error was attributed. Examples of each type of error of fallacy are presented.

Table 2: Number of articles containing 'All substantiated' through to 'All unsubstantiated' facts on efficacy and safety for Meningococcal B vaccine by year.

	Substantiation score					
Year	1	2	3	4	5	Total
2002	5	0	1	0	0	6
2003	5	0	0	0	0	5
2004	28	3	2	2	2	37
2005	19	7	1	0	1	28
2006	38	14	1	1	0	54
2007	6	1	0	0	0	7
	101	25	5	3	3	137

Results

Errors of fact (scientifically substantiated and unsubstantiated content)

A total number of 360 articles from 2002 to 2007 (average of 60 per year) containing information pertaining to the efficacy, effectiveness or safety of vaccines were identified and analysed using the substantiation scoring system. Independent coding of the substantiation scores gave a Kappa score of 0.97 indicating a strong level of inter-rater agreement.

Overall, 21% (n=76) of the articles contained some factually unsubstantiated information about vaccine efficacy or safety. Examples of the types of factual error are presented in Table 1.

Articles reporting new vaccines were usually accurate. For example, news about the human papillomavirus vaccines was emerging and centred around their potential to protect against cervical cancer. Of 24 articles, only one contained any scientifically incorrect information, and there was no unsubstantiated information about the new conjugate Pneumococcal vaccine. Similarly, articles referring to well-established vaccines not in routine use (such as rabies) or the now-redundant vaccine for smallpox were all factual.

On the other hand, 33% of articles about the MMR (measles, mumps and rubella) vaccine contained erroneous information. This is likely to reflect the negative press this vaccine has received in the past, including the erroneous claim in 1998 that it was associated with autism.[1,16,17]

Approximately a quarter of articles (26%) about the NZ-specific vaccine against a specific strain of group B meningococcus contained scientifically unsubstantiated information. This vaccine was introduced in response to an epidemic starting in 1991, which had resulted in a number of deaths and severe morbidity.[18] Prior to

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the development of a vaccine the media regularly reported tragic cases of the sudden deaths and disabilities of young people. In 2003 phase II trials were conducted on NZ children[18] and 2004 saw the roll-out of a nationwide immunisation campaign to all children from infancy to aged 20 years, which was completed in 2006.[19]

Table 2 presents the number of articles containing unsubstantiated facts on efficacy and safety for the meningococcal B vaccine by year. In Figure 1 it can be seen that the quantity of non-scientific information about the vaccine dramatically increased through the roll-out phase, but by 2007, when both the epidemic and the mass vaccination program were over, this again declined.

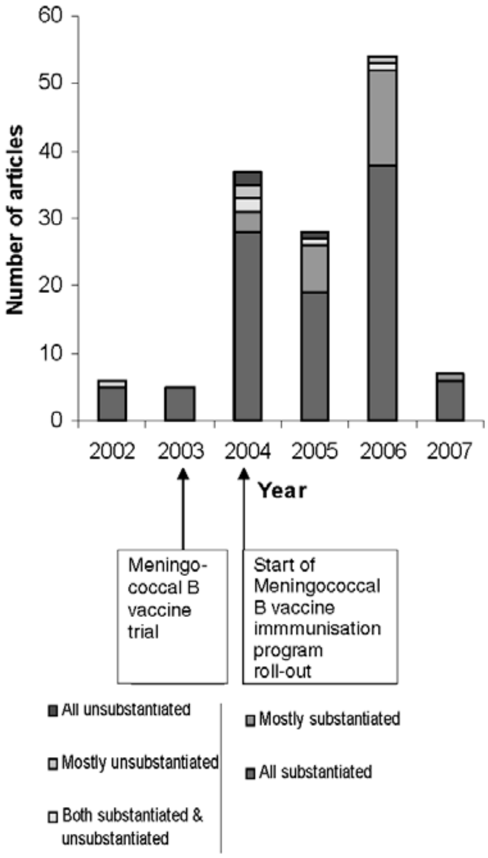
Errors of logic

Many articles contained a number of errors of logic (fallacies) as well as fact. These met most of the types of fallacy in our taxonomy, and examples are shown in Table 3.

While these errors were predominantly used by those opposed to immunisation, supporters were not exempt from using such strategies. For example, the Ministry of Health statement that the meningococcal B vaccination was 'safe' over-states the case (adverse reactions do occur). The statement that "*all three injections of the MeNZB vaccine are needed*" also is not entirely correct (some vaccinees develop protection from two doses).

Most of the fallacies occurred in quotes contained within the article rather than as a result of assessment by the reporter.

Figure 1: Progression of unsubstantiated statements about Meningococcal B vaccine over time.



Discussion

This study reviewed errors of fact and logic in articles published in the major NZ daily newspapers concerning vaccines and immunisation over a six year period.

Strengths of the study include the comprehensive dataset comprising all articles pertaining to immunisation and vaccination in all four major NZ daily papers, analysis for errors of both fact and logic, the strong level of inter-rater agreement and the following of trends over time. A weakness is that while we developed a relatively robust taxonomy of fallacies, there is no one standard for this and some errors may be able to be categorised into more than a single category simultaneously.

This study has important implications. Understanding how arguments presented in the media are constructed can both assist health professionals in addressing vaccine issues that appear in the media and allow the avoidance of the use of fallacious arguments themselves. By looking beyond the superficial we can deconstruct arguments to expose the errors – sometimes we feel something sounds wrong but are not sure why. When we know how to identify a fallacy we can counter it more effectively.

In most countries, including NZ, the media wish to be seen as impartial and guidelines on impartiality and diversity of opinion as well as accuracy exist.[23] In NZ, the Press Council exists to consider complaints, promote freedom of speech as well as maintain the press in accordance with the highest professional standards. The Press Council does not prescribe rules by which publications should conduct themselves, rather editors have that responsibility.[23]

The journalism code of ethics reflects The Press Council statement of principles[24] of which two areas are particularly pertinent to reporting of immunisation issues:

- Accuracy – publications (newspapers and magazines) should be guided at all times by accuracy, fairness and balance, and should not deliberately mislead or misinform readers by commission, or omission.
- Comment and fact – publications should, as far as possible, make proper distinctions between reporting of facts and conjecture, passing of opinions and comment.

Presentation of a range of views is clearly important – particularly on political topics, or in areas of health where the knowledge is incomplete and continuing to evolve. Established health issues such as national immunisation programmes however have already been scrutinised for scientific validity, and are part of national public policy and usually a priority. The 'truth' has already been subject to assessment by many experts and generally is not something that can be evaluated based on a media story presenting a range of quotes in pursuit of 'balance'. Ironically, introducing a balance of personal views on a subject such as immunisation can introduce bias with public health the casualty.

Media presentation of a new vaccine changes over time in terms

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of scientifically substantiated information. For new vaccines, prior to introduction, the coverage is less emotive and more scientifically substantiated, focusing on the potential of the vaccine to prevent disease. This may be a reflection of the general low level of interest in new vaccines by anti-immunisation lobbyists, and the higher level of interest in the disease by the community experiencing its effects.

Following the routine use of a vaccine the proportion of unsubstantiated reporting increases, including fallacious arguments. These arguments are used by both supportive and anti-immunisation spokespeople, although more commonly by those opposed to immunisation. Most arguments proposed by anti-immunisation lobbyists have been demonstrated to be fallacious.[4,20-22] Apparent here is the failure of the press at times

Table 3: Examples of errors of logic about vaccination appearing in the New Zealand print media 2002–2007.

Type of error	Example	Comment
Post hoc ergo propter hoc (affirming the consequent)	"An Oamaru pupil says the meningitis vaccine caused him to collapse and spend a night in hospital." Reporter, *Otago Daily Times*, June 2005	Assumes that because the vaccine was given first it must have caused the collapse.
Cum hoc ergo propter hoc (denying the antecedent)	"…some reports suggest there are high levels of absenteeism as a result of that [MeNZB injections]. When vaccination coincides with the beginning of the cold and flu season you would expect to see quite high rates of absenteeism. We believe all vaccines place a strain on the immune system." Immunisation critic, *NZ Herald*, 2005	Assumes that the vaccine causes other illnesses to occur at the same time its administration.
Circulus in Probando (arguing in a circle)	….. "You've got to give kids' immune systems a chance to grow. It's better to build immune systems so they can fight things themselves" Reporter, *The Press*, 2006	Assumes the answer to developing a good immune system requires experiencing vaccine preventable diseases.
Dicto simplicter ad dictum secundum quid (fallacy of accident)	"All three injections of the MeNZB vaccine are needed." Ministry of Health, *Otago Daily Times*, 2005	Does not consider exceptions. Sometimes 2 doses of this vaccine were sufficient.
Dicto secundum quid ad dictum simpliciter (reverse accident)	Critics of the program say the toddler was a victim of vaccine failure, and are calling for a Royal Commission of Inquiry into "how a nation can be so totally swayed by officials and advisers into spending a quarter of a billion dollars for such a gamble that has delivered false hope to trusting New Zealanders." Reporter, *NZ Herald*, 2006	Generalises from a single case (of vaccine failure) to suggesting the entire program is a failure. Vaccine failures are expected as no vaccine is 100% efficacious.
Fallacy of the consequent	"Some people don't like altering the children's immune systems with anything. Kids that don't get immunised are actually healthier on the whole." GP, *The Press*, 2005	Concludes that unimmunised children are healthier, however this is not supported by the premise "some people don't like altering the children's immune systems with anything."
Verbal fallacies (emotive language)	"These child guinea pigs for the nation [children receiving MENZB vaccine]", Reporter, *The Press*, 2004	Wrongly implies that children are being experimented on
False attribution	"Risk analyst Ron Law, a critic of the vaccination program, said the program had been a failure." Health reporter, *NZ Herald*, 2006	The term "risk analyst" implies expertise on the subject when in fact there is none giving the statement more credibility.
Ignoration Elenchi (irrelevant conclusion)	"Ms Claridge [Immunisation Awareness Society] says that during the 50 years leading up to the 1940s when vaccination programs began, the incidence of communicable diseases had already dropped dramatically because of better sanitation, hygiene, water supplies, housing and nutrition" Reporter, *Dominion Post*, 2002 "She says that diseases such as scarlet fever have also declined hugely during the past 110 years, despite the absence of a vaccination program." Immunisation critic, *Dominion Post* 2002	Diverts attention away from the issue at hand which was the Meningococcal B vaccination program, and discusses the decline of vaccine preventable diseases. The decline of scarlet fever is largely due to the development of antibiotics and vaccination is irrelevant.
Argumentum ad hominum (shoot the messenger)	"I realised one day that there were two kinds of doctors – there is the GP who knows bugger all about a lot and the specialist who knows a lot about bugger all." Vaccine critic, *NZ Herald*, 2006 "And you can be sure that doctors Tukuitonga and Turner will not be taking the blame because, for all their protestations of immunisation safety, they would not know an adverse reaction if it jumped up and bit them." *NZ Herald* 2002	Both of these criticise the messenger rather than the message – a personal attack.
Argumentum ad verecundiam (attribute to misleading authority)	"The Society says breastfeeding for at least 6 months and a healthy diet and environment for children provide better protection [than immunisation]" The Immunisation Awareness Society, *The Press*, 2006	The Immunisation Awareness Society have no credentials in science nor paediatrics.
Straw man argument	"The medical profession says Pamol is completely safe", Reporter, *NZ Herald* 2004	The medical profession do not hold the view that paracetamol is completely safe. This is misappropriating their position.
Fallacious anecdotal evidence	"I have seen case histories of children, and spoken to other doctors whose children decompensated [regressed] so drastically after the MMR that you can't deny that in some cases it happened." Neurologist parent of child with autism, *NZ Herald*, 2006	Anecdotal evidence only. Fallacious because is assumes the Post hoc ergo propter hoc (affirming the consequent).

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to verify both the material and the credibility of their sources. In this there may lie the conflict between the drivers and constraints journalists have and the need for health professionals and scientists to provide accurate information to the public.

We found both errors of fact and logical fallacies. Both those who support and detract from immunisation use these, however anti-immunisation proponents are more likely to include errors. It appears from the examples presented in this study that the media are frequently content with providing the diversity of opinion without investing the same effort to verify the accuracy or source, instead settling for providing quotes from a range of sources to fulfil their journalistic balance. The term 'balance' in this context is a media construct in contrast to scientific balance. Additionally, the errors of omission and commission are explicitly mentioned in the media principles, however, they appear frequently in media articles.

Until there can be both recognition of the problem and shared commitment to solutions between media drivers and the protection and promotion of public health, confidence in immunisation programs will continue to be eroded. The responsibility for accuracy lies with both public health spokespeople as well as the media. Firstly, the importance of recognising and critiquing public health arguments in the media needs to be accepted practice. This needs to become a routine part of health professional and media training. Many of these errors in the media could be prevented by regularly reviewing and highlighting fallacious practice to both journalists and health professionals.

Secondly, the current practice of utilising a diversity of views without appropriate emphasis on the validity of the views needs strong counter measures. Striving "*to disclose all essential facts and by not suppressing relevant, available facts or distorting by wrong or improper emphasis*" is already an integral component of New Zealand journalists' code of ethics,[24] but this is on a voluntary basis only. Stronger public relations strategies that consistently and fairly continue to challenge poor quality articles are required for the implementation and enforcement of this existing code of practice.

Thirdly, the health sector needs to be more prepared for challenges that arise with the introduction of new public health initiatives such as a new vaccine, recognising and redressing the expected pattern of initial supportive media frequently followed by suspicion and anti-science rhetoric. Public health relations strategies need to be more proactive in predicting and pre-empting the expected responses.

Finally, health professionals need broader and more effective training to be prepared for the challenges of communicating in the media including the use and misuse of language and the importance of effective media engagement. The best product in the world will not sell without knowing how to communicate it to the audience.

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The use and misuse of media headlines: lessons from the MeNZB™ immunisation campaign

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Abstract

Aim Tracking the use of headlines with single issue stories in the New Zealand print media from their source, three case studies of the MeNZB™ vaccination campaign's presentation in the print media were examined.

Method Article headlines were tracked in the three case studies. All headlines were coded between two researchers to review for accurate or misleading presentations in terms of whether the headlines matched the article content.

Results In these three case studies 26 out of 51 headlines were inaccurate when compared with the article content (51%), with a further 6 being misleading (total of 61%).

Conclusions These small case studies illustrate the difficulties arising at the intersection between media and public health interests. There is an inherent tension between public health publicity needs, and the print media needs. To maintain public confidence, health planners constantly need to develop and review their health promotion messages and relationships with the media. Close and ongoing dialogue between media and public health professionals are important, with recognition on each side of the different drivers and needs in two different sectors.

New Zealand's (NZ's) rates of meningococcal B disease were reaching over 200 per 100,000 children less than 1 year of age in 2004.[1] NZ's largest immunisation programme was implemented in July 2004 in response. A strain-specific vaccine was designed specifically for the NZ epidemic, and provided for all children aged 6 weeks to 20 years of age in the country. The delivery programme commenced in the area of highest disease rate, South Auckland, and then rolled out progressively around the country to children in all areas over the next year.[2] By 2006, over 3 million doses of vaccine had been delivered to NZ children and youth.[3] With the recent cessation of the MeNZB™ programme, it is timely to investigate some of the lessons learnt by understanding a snapshot of this campaign's portrayal in the media.

Media activities can directly affect immunisation uptake both positively and negatively.[4] Media reports questioning vaccine safety can significantly affect parental concerns.[5–8] and ultimately immunisation coverage rates.[9,10] Media reportage can also have a positive effect. A Cochrane review concluded that mass media should be considered a tool that may encourage use of effective health services and discourage those of unproven effectiveness.[11]

This research project focused on tracking single issue stories from their source during the MeNZB™ immunisation campaign. We tracked their spread through the NZ media, examining how the headlines for the stories were presented in different media in terms of accuracy or misleading presentations with respect to the story.

The reach of the mainstream print media in NZ is wide, covering all homes in all regions at least once a week (including the free regional newspapers), although not necessarily read in all homes. The NZ media uses the services of the New Zealand Press Association (NZPA), which is a 24-hour, 7-day-a-week service providing national and international news to the country's media. The NZPA news is available through its commercial division, NZPA Content Services. News is purchased for publication in newspapers and magazine, and is widely used by NZ print media nationally.

The subeditor of the newspaper, not the journalist who crafted the article, usually generates the headlines in print media articles.

Methods

NZ print media clippings were collected from 400 different national and regional publications for the years 2004/2005, covering over 5000 articles. These were obtained from a professional clipping agency which inspects all national daily and weekly newspapers, non-daily suburban and provincial papers, and magazines including health-related publications and provides copies of all articles that make reference to immunisation, vaccines, or vaccination.

All articles were entered into an Microsoft Excel database and fields included date, type and region of media source, title, and coding themes.

To analyse the use of a headline, all articles in 2004/2005 were scanned for articles that arose from a single NZPA story, and were taken up broadly by many media throughout the country. Case studies were selected based on being a single factual story around the meningococcal epidemic and vaccine, and having wide print media coverage to many regions in the country. Three examples were chosen as coming from a factual story and resulting in wide distribution throughout the country, both in national and regional print media.

The headlines were listed and coded separately by two independent researchers as being either an accurate presentation of the issue, ambiguous, or inaccurate when comparing the headline to the content of the article. The researchers were in agreement in all codings. If the headline reflected the content of the article it was coded as accurate, if it did not reflect the content of the article is was coded as misleading and if it reflected aspects of the story without clearly representing content, particularly the main focus, then it was coded as ambiguous.

Results

Story A—It is reported that initially one, then two, young children have caught meningococcal disease and are in hospital. While it is not known exactly what strain of meningococcal disease they have, it is established that neither has the epidemic strain type meningococcal B disease (type B:4:P1.7b,4). Both these children have been recently fully immunised against the epidemic strain, but this vaccine does not cover other strains of meningococcal disease.

The original story generated a total of 30 print media articles around NZ over the dates 22 November 2004 to 2 December 2004.

Of 30 articles, 9 had accurate headlines, 6 had ambiguous headlines, and 15 had misleading headlines. Two of the articles were from national media; both were in the misleading category.

Table 1. Story A: Comparing accuracy of headlines to content of article

Accurate	Ambiguous	Misleading
Immunised tot catches another strain of disease	No meningococcal vaccine 100 percent effective – ministry	Child not protected
Vaccinated child catches different meningitis strain	No vaccine ever 100% effective, says ministry	Vaccinated child in hospital
Vaccinated child catches different strain of disease	'No meningococcal vaccine 100 percent effective'	Toddler struck down
Vaccinated child catches variation	Vaccine not '100 percent effective'	Vaccine fails
Vaccinated boy sick with another strain of killer bug	Vaccinated children still at risk	Immunised children catch killer disease
Stay vigilant	Jabs can't give complete cover	Vaccine fails to protect
Jabs can't cover all strains		Two children develop meningococcal disease despite being immunised
Jabs can't protect against all strains		Two children ill despite vaccine
Vigilance advised		Two children have disease
		Two ill, despite vaccine
		Two develop meningococcal disease after vaccine
		Two children developed meningococcal disease after vaccine
		Children catch disease
		Two meningococcal cases despite immunisation
		Sick children no surprise to anti-jab campaigner
n=9 (30%)	n=6 (20%)	n=15 (50%)

Story B—The story announces the first day of the launch of the mass meningococcal B vaccine programme for children aged 6 months to 5 years in Central Auckland, the largest city in NZ, and Northland (the most northern province). The main themes are announcing the launch, and discussing vaccine safety, quoting the Independent Safety Monitoring Board (ISMB) findings and the clinical trials findings, which all found no major safety issues.

The story also quotes the opinion of an anti-immunisation lobbyist who gives anecdotes of children reputed to have reactions to the vaccine. This story generated 8 articles all on the same day. For a total of 8 articles there were 3 accurate headlines, and 5 misleading headlines.

Table 2. Story B: Comparing accuracy of headlines to content of article

Accurate	Misleading
Meningitis jabs begin	Dispute over vaccine risk goes on
Preschoolers get jabs	Mass vaccination proceeding despite concerns
Vaccinations begin	Vaccine debate continues, 25,000 face needle
	Vaccine row rages
	Meningococcal vaccine risk dispute goes on
n=3 (37.5%)	n=5 (62.5%)

Story C—The Minister of Health visits a health centre and announces a milestone in the campaign: more than 2 million meningococcal B vaccine doses have now been delivered nationally to almost 78% of the eligible population.

The programme aims to achieve 90% coverage with all 3 doses (and still has another year to run) and the Ministry spokesperson reports that it was unlikely to reach this goal in all areas, but was likely to reach targets in the most important high risk groups (see Table 3). This story generated a total of 13 articles over the period 18–19 August 2005, and a further article on 31 August 2005.

Overall 7 headlines were accurate and 6 were misleading. Note that here headlines were coded as misleading if they focused on overall campaign failure: while the statement was that some areas may not reach the target, this does not mean the target overall will not be reached, and furthermore targets were expected to be met for the highest risk groups who were the key focus of the campaign.

Table 3. Story C: Comparing accuracy of headlines to content of article

Accurate	Misleading
Acceptance of vaccine widespread	Vaccination goal may be missed: ministry
Milestone for vaccine plan	Vaccine drive short of goal
Vaccine campaign reaches 2 million	Vaccine goal unlikely to be met
Two million doses delivered	Vaccination campaign falling short
Heavy dose	Campaign falls short
Two million doses of vaccine delivered	Meningococcal likely to miss target
Two million doses of vaccine now delivered	
n=7 (54%)	n=6 (46%)

Table 4. Summarising accuracy of all headlines to all articles

Headline and content accuracy	Total (stories A, B, C)
Misleading headline	26 (51%)
Ambiguous headline	6 (12%)
Accurate headline	19 (37%)
Total	51 (100%)

Discussion

Public health consequences of media activities are well documented internationally, and can be dramatic, such as the case of pertussis in the 1970s and 1980s where negative press lead to reduction in immunisation coverage internationally and consequent disease outbreaks.[9] In Wales there was extensive adverse print media coverage of the measles, mumps, rubella (MMR) vaccine in one local newspaper from June to September 1997. Following this there was a 13.6% decline in vaccine uptake in the distribution area of that publication compared to a decline of only 2.4% elsewhere,[10] illustrating the power of local newspapers.

It is a challenge for national vaccination campaigns to present data and stories that will be taken up accurately by media. These small case studies illustrate the difficulties arising at the intersection between media and public health interests. The needs and drivers for the print media differ from public health drivers. Media needs are focused around selling the story, not around accuracy of a health message. Key aspects of a good media story include making it relevant to the reader, to their personal current concerns, and of human interest. Essentially the print media needs to engage the audience to sell the product.

Research to date has focused on the content of articles, not on the headline. These case studies are focusing on the impact of the headline, and how it matches to the article. Headlines are frequently developed by subeditors independently of the journalists who write the articles, and hence there can be quite a difference in intent between the headline and the article.

In these three case studies 26 out of 51 headlines were misleading (51%), with a further 6 (12%) being ambiguous (total of 61%).

Implications—To maintain public confidence, health planners constantly need to develop and review their health promotion messages and communications with the media. This requires broad relationships with many levels of media, not just with the national origins of the stories, but also the local media management of stories and of the headlines. There is an inherent tension between public health publicity needs, and the print media needs. To reconcile these competing needs health planners need greater awareness of triggers and drivers in the media world. More research is needed into how specific public health issues are reported in the media so health planners are able to better understand media drivers.

These case studies clearly demonstrate a wide range of responses generated within the media to the same story, showing there is not a standard predictable response, and individual journalists and subeditors can chose very different angles on the same theme. One can assume it will be difficult to consistently predict the behaviour of the print media with any one story.

Journalistic and print media needs can be in conflict with responsible presentation of public health messages. Close and ongoing dialogue between media and public health professionals are important, with recognition on each side of the different drivers and needs in two different sectors.

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Family physician perspectives on barriers to childhood immunisation

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Abstract

New Zealand (NZ) has inadequate vaccine coverage and associated disease outbreaks. International research illustrates the importance of provider behaviour in improving vaccine uptake. To understand the immunisation knowledge, views, concerns and educational needs of NZ family physicians, qualitative and quantitative national data was gathered from randomised telephone surveys. Response rate was 60% with respondents' characteristics closely matched to key demographics of NZ family physicians. The most significant barrier to improving immunisation rates identified was parental concern over vaccine safety and associated misconceptions. The second major barrier identified was lack of funding to health providers. A clear need for improvement in family physician knowledge of contraindications to vaccines was highlighted. Family physicians expressed a need for better resources to more effectively address parental fears and misconceptions. Strategies to address these issues include an increased focus on family physician educational needs, extra resources to assist with more effective communication to parents and a review of the present funding of providers for immunisation services.

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Keywords: Immunisation; Family physician; Communication

1. Introduction

New Zealand (NZ) has benefited less from the improvements to population health made possible by immunisation than many other countries. Primarily this results from low immunisation coverage. In 1998 UNICEF data indicated that 102 of the 193 listed countries had higher immunisation rates for the primary infant series than NZ [1]. For immunisation programmes to be fully effective they must maintain high coverage levels, for example elimination of measles in a population requires a coverage rate of at least 95% [2]. The NZ Ministry of Health has set 95% coverage by 2 years of age as the national target [3]. NZ is responding to the current low coverage with the development of an immunisation register to track children's immunisation status, and increasing availability of outreach services. Also implemented has been a national immunisation hotline providing advice to both public and health professionals. Until the register implementation is complete the only accurate national coverage data is provided by the 1992 national coverage survey, which found that less than 60% of children were fully immunised by age two years [4]. Of further concern, only 45% of Maori and 53% of Pacific Island children were fully immunised. A repeat coverage survey in 1996 in the northern region found minimal improvement, with 63% of children fully immunised at 2 years [5]. There has been no apparent improvement in coverage since then [6].

In contrast, immunisation coverage has improved substantially in both Australia and the United States in recent years. This improvement is the result of multifaceted approaches [7,8]. An integral component of the improved coverage in both of these nations has been the increased emphasis on communicating vaccine safety issues.

International research has clearly identified health provider knowledge about immunisation as an important factor in vaccine uptake [9–11]. There are likely many reasons for this including effective risk-benefit communication [12].

NZ has an active anti-immunisation lobby [13] and local evidence suggests that despite efforts to better communicate immunisation messages to the public, the activities of the lobby group contribute to the eroding of public confidence [14].

Recent studies have indicated that many NZ parents have low confidence in immunisation and their concerns are

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primarily in regard to vaccine safety [15]. Of major significance is that this current lack of confidence is strong enough that it may in itself be sufficient to prevent achieving the 95% target uptake rate [16].

The immunisation programme for NZ infants is delivered within the general practice setting. Over the past decade practising obstetrics has become less viable for general practice obstetricians, and their role has been taken over by midwives and specialist obstetricians. As the majority of antenatal care now is usually provided outside of general practice, there is less opportunity both before the birth of a child and shortly after for family physicians to discuss immunisation with parents. Providers of primary care have a unique opportunity to educate parents because parents see them as the most important source of information about immunisation [17].

The intent of this study was to understand the immunisation issues confronting family physicians in NZ using a national randomised computer-assisted telephone survey. The questions focussed on general practice organisation issues; family physician perceptions of barriers to improving immunisation; family physician knowledge and educational needs regarding immunisation; preferred resources, and their own practices around immunisation.

2. Methods

This study used a triangulation, multi-method investigation to understand immunisation issues confronting GPs by converging both quantitative and qualitative text data.

2.1. Sample population

The study was carried out in Auckland, NZ between July 2002 and January 2003. The subjects were family physicians practising throughout NZ. The inclusion criterion was any doctor working at the practice either part or full-time. Doctors working in locum tenure positions were excluded. A randomised list of 1283 national general practices was obtained from a commercial vendor and allocated to the interviewers. This source is the most comprehensive and reliably updated database available to NZ researchers. All practices carrying out childhood immunisations were considered eligible. In multi-practitioner settings the interviewers spoke to the first practitioner available.

The sample size of 150 is justified by sample size calculation using EpiInfo 2000. For a population of approximately 3000 (total number of NZ Family Physicians) with an expected frequency of 53% who would know that egg allergy is not a contraindication to MMR vaccination (based on international literature [9]) ±8%, and to get 95% confidence level, a sample of 142 people is needed. The precision of the estimate was assessed by using standard error and 95% confidence interval, which is acceptably small (±8% with a potential of further reduction for situations where expected frequency is lower than 47%).

The study had University of Auckland Human Ethics Committee approval.

2.2. Questionnaire design

The design of the questionnaire was based on areas identified in the medical literature as barriers to immunisation. It also explored the educational needs and preferred sources for immunisation information.

2.3. Telephone interviews

Interviewing was facilitated by a computer assisted telephone survey tool that managed the sample and questions. The interview lasted about 20 min. Answers were entered directly into the database for collation and analysis. Quantitative responses included yes/no answers; Likert scales, multi-choice options and demographic data including age, gender and nature, duration in, and location of, practice.

Qualitative data involved free-form answers to questions including other perceived barriers to immunisation; sources of information about immunisation and services provided by the family physician regarding immunisation.

2.4. Data analysis

Quantitative data analysis was conducted using EpiInfo 2000 where differences between groups were sought.

Cross tabulations were carried out to determine differences between age groups; years in practice; urban versus rural and responses to some of the key areas.

The free-form data responses were analysed using a general inductive approach. Individual text responses were initially analysed to identify sub-themes. The data was then collated and analysed for emerging categories. These were combined into major themes through ongoing discussions and re-reading of the data by the first two authors until consensus was reached regarding the main themes being expressed. The data were independently double-coded as a consistency check and discrepancies resolved by adjudication. These responses were collated and analysed to identify themes, which were combined through discussions between two of the researchers until consensus was reached.

3. Results

3.1. Response rate

A total of 250 randomly selected practices were contacted to reach a sample of 150 participants (60% response rate). Of the 100 non-responders, 23 (9%) Family Physicians contacted refused to participate; 12 (5%) were initially willing to take part but decided they were too busy after call-backs; 25 (10%) receptionists refused to put the call through to the family physician; 23 (9%) did not qualify (for example, sports medicine clinics), and 17 (7%) were lost to follow-up (failure to call back before the end of survey).

Of the 150 family physician participants, 111 (74%) were male; 123 (82%) worked full-time ($\geq$8/10); 51 (34%) worked as sole family physicians; 35 (23%) were from rural settings; and 122 (81%) had been practising 10 or more years, with 46 (31%) > 20 years. The majority, 119 (79%, were aged 40 years or older, with 78 (52%) in the 40 to 49 year age bracket. The average age was 44 years, the same as that of the family physician population nationally. In general these demographic characteristics are similar to those of the Royal New Zealand College of General Practitioners membership documented in 2001 from 1996 and 2000 data [18] in terms of age and years in practice. Our sample was matched for the main city centres Auckland (33%), Wellington (7.3%) and Christchurch (9.3%). However it had a greater representation of rural participants than the national practitioner population (23% compared to 15% [19]). Although we had a larger representation of male over female practitioners compared to the actual practitioner population (74% male compared to 64% nationally) there were no significant inter-gender differences in responses to several key questions.

3.2. Barriers to immunisation

Family physicians' responses to a list of possible barriers to immunisation are presented in Table 1. The greatest barrier perceived by family physicians was parents' fear of vaccinations (53%), followed by lack of funding for providers (44%). Only 13% identified difficulty in patient access as a significant barrier.

The view that lack of knowledge in health professionals was a barrier to immunisation was more likely held by participants under 40 years ($\chi^2 = 6.54$ 1df $P = 0.001$. Urban rather than rural family physicians were more likely to see patient difficulty in accessing services as a barrier ($\chi^2 = 9.84$ 1 df $P \leq 0.002$). In view of longer travelling times, remoteness and lower ratio of physician to patient in rural areas this was a surprising finding.

The participants then were asked about other barriers to immunisation that were not covered in the list. The strongest theme to emerge was misinformation. Comments centred on the misinformation about immunisation distributed by both midwives and the anti-immunisation lobby groups. Family physicians re-emphasised patients' fear of vaccinations due to this misinformation. They also identified a lack of resources, both to inform themselves and also in formats to help educate patients and counter the misinformation. Another strong theme was the lack of opportunity to vaccinate because of a mobile population base, or because they no longer had ready access to their women patients antenatally or in the early post-natal period. Structural issues such as such as changing schedules, cold chain, lack of patient registration were a concern, and some family physicians felt that there was an apathy on the part of their patients towards vaccination, particularly because some of the diseases are no longer witnessed by the community.

3.3. Practitioner knowledge

As international literature has shown that the knowledge of health professionals, especially of contraindications, is the single most important factor in immunisation uptake we asked participants questions about what they considered were contraindications to MMR and pertussis immunisation (Table 2).

Urban rather than rural family physicians were more likely to know that a rash in response to eating eggs is not a contraindication to MMR vaccination ($\chi^2 = 11.21$, 1 df, $P = 0.0008$). A desire for further knowledge about vaccine side effects was more likely in those who had been practising less than 10 years ($\chi^2 = 4.5$ 1 df $P \leq 0.05$). Participants under 40 and those who had been in practice for less than 10 years were more likely to view parental fear of vaccination as a barrier ($\chi^2 = 7.26$ 1 df $P = 0.007$ and $\chi^2 = 5.62$ 1 df $P = 0.018$, respectively).

Participants were also asked whether they considered 6 weeks to be too young for babies to receive immunisations. Nearly 5% felt this to be so and a further 6% considered sometimes 6 weeks was too young. Of these 16 responses, six thought 8 weeks would be preferable; four thought 10 weeks and six thought 12 weeks would be a more suitable minimum age.

Resources participants were most likely to refer to for further information regarding immunisation were the latest copy of the Ministry of Health Immunisation Handbook

Table 1
Family physicians' perceived barriers to improving immunisation $N = 150$

Barrier	Agree (%) (*n*)	Neither agree nor disagree (%) (*n*)	Disagree (%) (*n*)
Parental fear regarding immunisation	53 (80)	21 (32)	27 (41)
Lack of funding for providers	44 (66)	15 (23)	41 (62)
Lack of time for providers to offer services	28 (42)	13 (20)	59 (89)
Poor Ministry direction	27 (41)	23 (35)	49 (74)
Patient difficulties accessing services	13 (20)	14 (21)	73 (110)
Lack of interest in the topic by providers	11 (17)	13 (20)	75 (113)
Lack of knowledge in health professionals	8 (12)	11 (17)	81 (122)

Table 2
Results for perceived contraindications to MMR and pertussis vaccinations ($N = 150$)

	Correct answer rate (%) (*n*)
Perceived contraindication to MMR vaccination	
Baby gets a rash eating eggs[b]	36 (54)
Baby has spina bifida and hydrocephalus[b]	48 (72)
Baby being treated for leukaemia[a] (actual contraindication)	56 (84)
Mother pregnant[b]	66 (99)
Baby had a febrile convulsion at 11 months[b]	73 (110)
Baby with snuffly cold/nasal discharge[b]	79 (119)
Sibling has ADHD[c], Autism or Aspergers[b]	81 (122)
Mother breastfeeding[b]	89 (133)
Baby reported to have had measles[b]	91 (137)
Baby has eczema[b]	95 (143)
History of parental febrile fits[b]	97 (145)
Perceived contraindication to pertussis vaccination	
Baby had a HHE[d] following previous immunisations[b]	6 (9)
History of parental febrile fits[b]	97 (14)
Screaming for >3 h after previous immunisation[b]	39 (58)
Baby had apnoea in first 3 weeks[b]	50 (75)
Baby has motor delay[a] (actual contraindication)	65 (97)
Baby has spina bifida, no leg weakness[b]	65 (97)
Baby with snuffly cold/nasal discharge[b]	85 (127)
Older sibling had fever following DTaP[b,e]	94 (141)
Baby has eczema[b]	97 (146)
Sibling has eczema or asthma[b]	100 (150)

[a] Is a contraindication.
[b] Is not a contraindication.
[c] DTaP: diphtheria, tetanus and acellular pertussis vaccine.
[d] HHE: hypotonic hypo-responsive episode.
[e] ADHD: attention deficit hyperactivity disorder.

(97.3%); their local immunisation coordinator (53.3%); CME (63.3% and colleagues (66%)—usually a practice nurse. Other sources for information were mainly medical journals. Only 47.3% said they were internet users and preferred sites were Ministry of Health, CME websites, CDC and various databases such as Medline. Family physicians were asked if there were additional areas on which they required information. There were 69 respondents to this section. Analysis identified and categorised responses into four themes: updates on own knowledge on diseases and vaccines; patient resources (to counter misinformation, risk versus benefit information, non-English resources); rapid communication on emerging issues such as media responses, and travel information.

4. Discussion

This is the first comprehensive survey of NZ family physicians regarding immunisation—knowledge, attitudes, needs and practices, and their views on patient barriers to immunisation. The sample approximates the NZ family physician population demographics suggesting those who participated are representative of this population. While the views of family physicians may not reflect issues that lie outside their own experiences, they are the primary health care professionals to whom most members of the population go for primary care.

We have recently studied the knowledge and attitudes of NZ mothers around immunisation and found a pervasive underlying fear of vaccines and perceived side effects [15]. Concerns were present regardless of the vaccination status of their children. Parents who have vaccinated their children held fears as well as those who actively object to vaccination, and this was consistent across socio-economic groups [20]. These findings have not to date been strongly responded to in NZ where strategies focus predominantly on structural barriers to accessing services.

Our findings show that family physicians believe the largest barrier for parents is fear (53%) and that information is a problem, both in terms of misinformation and lack of information. They rated patient difficulties in accessing services as an unlikely barrier to improving immunisation with only 13% totally agreeing with the statement.

The second largest barrier identified by family physicians (44%) was the lack of funding to health providers. Scheduled immunisation for Tetanus, Diphtheria, Pertussis, Polio, Hib, Hepatitis B, Measles, Mumps and Rubella is free to NZ children. The government provides the vaccines to the family physicians and pays an average of $NZ16.40 per immunisation event. However family physicians need to meet the costs themselves of cold chain requirements and maintaining a recall system. The latter includes software costs, staff time, mailing and telephone costs if the recall is posted. Many family physicians do not believe that the funding provided covers their costs in providing this service, and that compliant costs are a significant issue for them. A 1998 NZ study found that given the frequency of recall reminders, there was a net cost to practices for childhood immunisation, after deducting the benefit rate [21]. A strong argument can be made for better funding the informed consent process, regardless of whether the ultimate outcome is parents agreeing or declining to the vaccination of their children.

Although participants rated their own lack of knowledge as the least likely factor in low immunisation coverage the participants in this study had a poor knowledge of contraindications to two primary vaccines—MMR and Pertussis (Table 2). International literature shows that poor knowledge of immunisation by health professionals, rather than attitudes, is the single biggest factor in vaccine uptake [9,11,22,23]. Interestingly, a minority of family physicians included a desire for further knowledge about the vaccines (32.7%) or knowledge around delivery techniques for vaccines (18.7%) and none included a further need for such information in the freeform answer – “What other areas would you like information about?”. Clearly there is a need to improve family physicians’ knowledge of contra-indications to vaccination in order to decrease the occurrence of missed opportunities.

The views of family physicians support the findings from other studies showing that parental concern over the safety of vaccines is the most significant barrier to immunisation for parents. Practitioners have acknowledged this by ranking the desire for resources to address parent concerns highly and it is imperative that these needs are met.

Primary health care provider commitment to immunisation is a key aspect of improving coverage. There are key issues from these findings to be considered in strategies to improve coverage levels in NZ. Firstly the need for an increased focus on family physician education needs to broaden their knowledge base, particularly in the area of contraindications to vaccination. Secondly, extra resources and strategies to assist with more effective communication and positive support for parents are required. Thirdly a review of the present funding of providers for immunisation services which is seen as a significant barrier to efforts to increase coverage.

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Research Paper

Immunization champions

Characteristics of general practitioners associated with better immunization delivery

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Abbreviations: CARM, Centre for Adverse Reactions Monitoring; CATI, computer-assisted telephone interview; GP, general practitioner; HHE, hypotonic hyporesponsive episode; MMR, measles, mumps and rubella; NS, non significant; NZ, New Zealand; UK, United Kingdom; US, United Atates of America

Key words: vaccination, immunization, family practice, primary health care, physicians, family

Our aim was to describe characteristics of GPs working in practices that achieve higher immunization coverage and more timely delivery. We conducted computer-assisted telephone interviews with randomly selected GPs from randomly selected practices. Most GPs believed immunization to be important and were confident about their knowledge of immunization although assessment revealed their knowledge to be incomplete. A minority considered six weeks is too young to immunize. Greater GP knowledge and confidence in their knowledge was associated with higher practice immunization coverage, whereas immunization delivery was more timely at practices where GPs perceived parental access difficulties a barrier.

Introduction

Childhood immunization is one of the most cost-effective activities in healthcare.[1] In NZ, immunization has eliminated polio and controlled tetanus and diphtheria.[2,3] Due to inadequate coverage however, the gains are not ideal. Disease persists, as seen with recurrent epidemics of measles and pertussis.[4,5] In NZ most immunization events are delivered through general practices and the vaccines are usually administered by primary care nurses. All scheduled vaccines are free including influenza and pneumococcal for special groups.

Vaccinator training in NZ is provided via a two-day course, with regular updates of four hours required to maintain vaccinator status. Few provider-oriented interventions have been demonstrated effective, and current education for vaccinators includes little on interventions for improving coverage, with the exception of reducing missed opportunities for immunization. The authors are currently running a randomized controlled trial to measure the effect of early engagement by practices with families of newborns with precall at four weeks for the first vaccination event at six weeks.

A national coverage survey in 2005 showed that 77% of children were fully immunized by two years of age. In contrast with the low national coverage, some primary care providers achieve much higher coverage rates. Primary health care groups in some NZ cities have reported immunization coverage of over 90% for two-year-old children enrolled in their practices.[6,7]

As demonstrated by the 1989–1991 measles epidemic in the US, timely delivery of scheduled immunizations is necessary for vaccines to achieve their full disease prevention potential.[8] Consistent with the international literature,[9-11] in NZ delay in receipt of the first vaccine dose in the primary series is one of the strongest and most consistent predictors of subsequent incomplete immunization.[12]

In the US and the UK the commitment of the provider has been shown to be the most important determinant of immunization coverage.[13,14] Effective and motivated services can achieve good immunization uptake even in the face of socioeconomic deprivation and parental uncertainty.[15,16] The increase in pertussis immunization coverage in England from 35% in 1979 to 85% in 1991 exemplifies this.[17] The improvements in immunization coverage were through encouragement of GPs rather than any improve-ments in the infrastructure of immunization service delivery, or introduction of coercive policies.[15,17,18]

Good health care provider knowledge also helps achieve optimal immunization delivery.[19] Considerable variability exists between health professionals in their immunization knowledge, particularly regarding false contraindications.[20,21]

The aim of this study was to identify those characteristics of GPs in NZ associated with higher practice immunization coverage and more timely immunization delivery. We hypothesized that GP attitudes about immunization influence the completeness and timeliness of immunization of their patients and that more accurate GP knowledge about immunization preventable diseases, vaccine contraindications and adverse events is associated with higher coverage.

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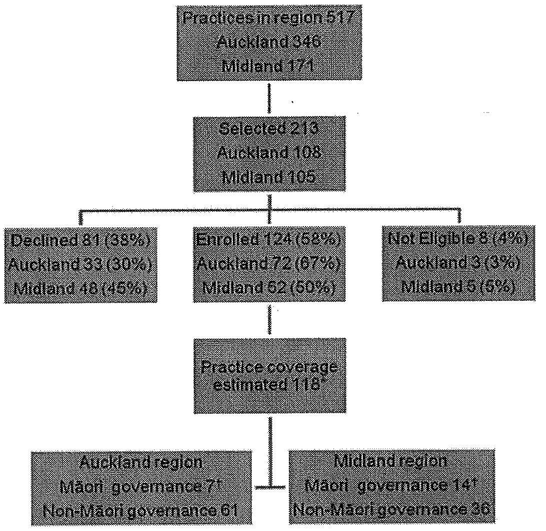

* At one practice none of the immunized children were registered

† Coverage for 4 Auckland and 3 Midland Māori governance practices were estimated as 1 practice

Figure 1. Summary of practice recruitment and enrollment

Results

Practice recruitment and enrollment is shown in Figure 1. Figure 2 provides a summary of the data sets in the overall study. Interviews were completed with 113 GPs representing 114 practices. Seventy-five (66%) were male. Eighty-seven GPs (77%) were aged between 40 to 59 years. A larger proportion of female GPs were under 40 years of age (24% versus 9%, $p = 0.04$). Ninety (80%) were working full-time. Forty-eight (42%) had more than 20 years, 37 (33%) had 10 to 19 years, and 28 (25%) less than ten years of practice experience.

In general, these demographics are similar to those of the Royal College of General Practitioners' membership.[22] In the 2007 RNZCGP membership survey, 61% of GPs were male, 72% were aged 40 to 59 years, 28% of females were aged under 40 years compared with 11% of males and 26% had less than 11 years practice experience.[23] The study setting was NZ general practices in two regions incorporating six District Health Boards in a mixture of socio-economic and rural/suburban/urban locations. Approximately 50% of all NZ children aged 0 to four years reside in the study region and are cared for by approximately 50% of the nation's GPs.[24]

Most GPs (108; 96%) believed immunization to be important or very important. The remaining five (4%) did not consider it important.

Practice nurse colleagues and the NZ Ministry of Health Immunization Handbook were both sources of immunization information for over 90% of GPs. Continuing medical education (64%) and named medical websites (54%) were also important sources.

Ninety-three (82%) GPs were comfortable or very comfortable with their knowledge of immunization. However their responses revealed significant gaps in their knowledge of immunization in general and specifically of true and false contraindications to immunization. Eighty five (75%) of GPs could not identify what the acronym 'CARM' stood for (Centre for Adverse Reactions Monitoring, the national centre where reports on possible adverse immunization events are sent).

GP knowledge was variable about contraindications to receiving MMR vaccine and pertussis antigen containing vaccines. Although allergy to egg is not a contraindication to receiving MMR, 14 (12%) incorrectly thought this was. One third of GPs did not know that a child being treated for leukaemia was a reason to delay MMR vaccine. Thirty-three (29%) stated they would delay the MMR immunization if the baby had a snuffly cold. The majority correctly identified that eczema, a previous febrile convulsion, a sibling with autism, baby previously reported to have had measles, or the mother pregnant or breast-feeding are not contraindications to MMR.

Only 20 (18%) correctly identified *"baby has motor delay"* as a precaution to pertussis vaccination. Some GPs wrongly identified previous hypotonic hyporesponsive episodes (HHE) (59; 52%) prolonged screaming (23; 20%) and apnoea (21; 19%) as contraindications to giving pertussis vaccine.

Ninety-nine (88%) GPs indicated that six weeks of age was an appropriate age to immunize. Four GPs recommended the minimum age as 10 or 12 weeks. Ten (9%) thought six weeks is sometimes too young, citing reasons such as circumstances of premature birth, low birth weight, early medical problems, serious infections or parent disagreement.

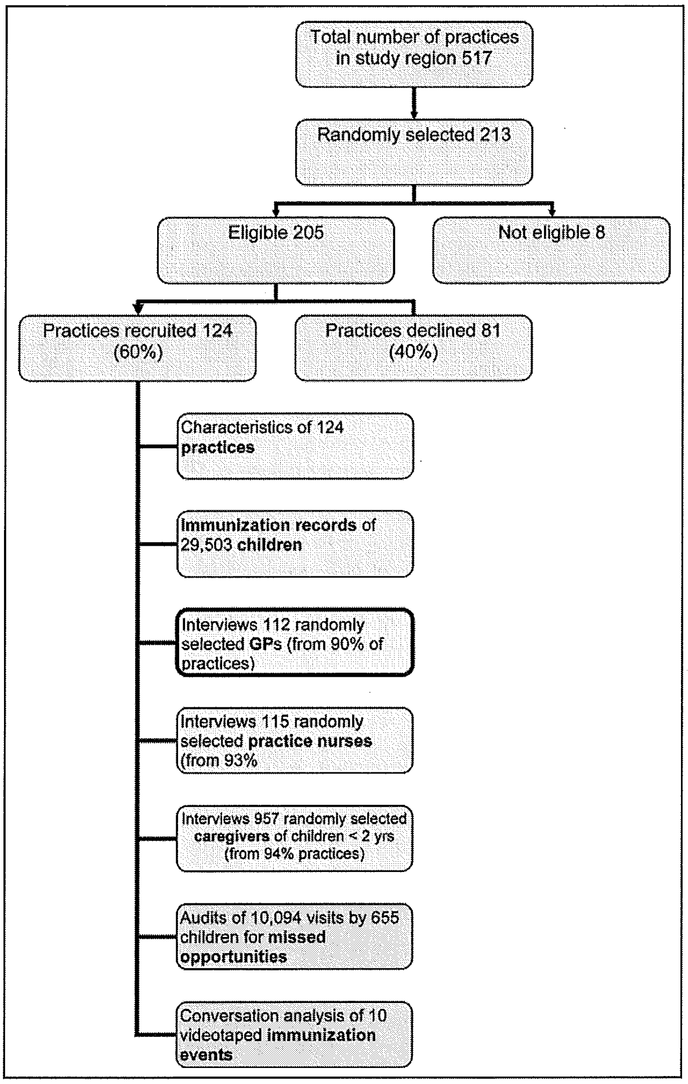
Total number of practices in study region 517
Randomly selected 213
Eligible 205
Not eligible 8
Practices recruited 124 (60%)
Practices declined 81 (40%)
Characteristics of 124 practices
Immunization records of 29,503 children
Interviews 112 randomly selected GPs (from 90% of practices)
Interviews 115 randomly selected practice nurses (from 93%
Interviews 957 randomly selected caregivers of children < 2 yrs (from 94% practices)
Audits of 10,094 visits by 655 children for missed opportunities
Conversation analysis of 10 videotaped immunization events

Figure 2. Summary of data sets in overall study

Fifty to sixty-six percent either agreed or totally agreed that parental apathy, fear and ambivalence or uncertainty around immunization were barriers to improving uptake. Other barriers identified included lack of transport, the anti-immunization lobby, inaccurate media information, misinformation and cultural values. Generally patient access difficulties, lack of funding and time for providers, health professional knowledge, or poor ministerial direction were not considered significant barriers to uptake.

Bivariate analysis. The significant associations between GP variables and immunization coverage are shown in Table 1. Both GP confidence in their knowledge about immunization and their accurate correct knowledge were independently associated with higher practice immunization coverage after adjustment for other confounding variables. Factors relating to teamwork, and perceiving parental apathy and fear as a barrier were no significant associates.

The associations between GP variables and immunization timeliness are shown in Table 2. After adjustment for region, governance, social deprivation and age of registered children, it was found that practices where the GP perceived that parental access difficulties were a barrier to immunization were better at providing immunization on time, as were practices where GPs were confident in their knowledge about immunization. None of the other GP characteristics and, in particular, none of those associated with practice coverage, were significant in the immunization timeliness analysis.

Multivariate analysis. In the multivariate modelling (Table 3) which included region, social deprivation, age of child, Maori governance and the effect of practice, GP, nurse and parental (caregiver) characteristics, the sole GP characteristic to remain significant for GPs for higher coverage was practices where GP confident in their knowledge. The GP perceiving parental access difficulties as a barrier remained significant factor in improved timeliness of immunization.

Discussion

Summary of findings. Particularly given NZ's poor record in immunization delivery and high pertussis hospital admission rate it is concerning that 4% of the GPs did not consider immunization to be important, and 12% felt that six weeks (the time the NZ schedule sets for first immunization) is sometimes or always too early.[25] A sizeable minorities of GPs shared poor knowledge regarding contraindications to immunization.

Greater GP knowledge and confidence was predictive of improved practice immunization coverage, suggesting that well-informed and confident GPs are better able to 'sell' immunization to caregivers.

GP perception that parental access difficulties was a barrier to immunization was associated with more timely practice immunization delivery. This indicates that a focus on population health not just personal care may improve coverage, and GPs' relationship with the communities they serve as well as individual patients is important.

Limitations and strengths. Practices were enrolled from two regions and were not necessarily nationally representative, although the practices were sampled from regions and practices where immunization delivery is likely to be more challenging.

This study used an independent, standardized measure of practice immunization coverage and timeliness. Prior to the recent introduction of the National Immunization Register, there was no consistent method assessing immunization coverage at the practice level in NZ hence between practice comparisons have previously been problematic. It addressed the issue of practice level coverage which is important given the role that practices play in immunization delivery. It also randomly selected one GP per randomly selected practice.

Comparison with existing literature. In international literature poor provider knowledge leads to a range of behaviors such as incorrect interpretation of contraindications and vaccine administration and missed opportunities to vaccinate.[20,26] A NZ national telephone survey in 2002/3 of 150 GPs noted that while respondents rated their own lack of knowledge as the least likely factor in low immunization coverage, their knowledge was relatively poor with rates of incorrect answers on contraindications reaching as high as 94%.[27]

While this study does highlight areas of poor knowledge with GPs, this is not significantly linked to lower timeliness of delivery of immunizations at the practice level. This may be because generally it is the practice nurses who organize the recall, delivery the immunizations and attend the vaccinator training courses in NZ. Timeliness is probably more related to commitment at each interaction and taking advantage of opportunistic moments.

Previously 5% of GPs felt six weeks was too young to immunized with a further 6% considered sometimes six weeks was too young.[19] This survey found 12% not agreeing that six weeks is a good age to immunize. In NZ delay in receipt of any of the three infant doses of pertussis vaccine is associated with a five-fold increased risk of hospital admission with pertussis.[28] Delaying initiation of the schedule for an infant virtually guarantees they will be exposed to this increased risk. Timely initiation of the schedule for all registered children would seem an appropriate measure of one of the essential roles of primary care, namely the prevention if serious illness.

Implications. Given the demographic similarities of our GP sample with the national workforce, and the fact that they were randomly sampled from 50% of the country's GPs, we are confident that our findings are likely to be representative throughout NZ. Furthermore, similar trends with respect to the feminization of the general practice workforce, with female GPs being younger and working less hours than their male counterparts are reported in other westernized countries such as Australia.[29] The findings of our study may therefore be generalizable to other western nations.

While there are clearly gaps in GP knowledge, generally these do not appear to influence immunization coverage rates at the practice level. Their confidence in their knowledge influencing coverage may be a reflection that these GPs are more motivated practitioners on immunization issues and support the literature that suggests it is the GP attitude more than their knowledge that is a more important factor.

A perception by GPs that parental access may be a barrier may lead to these GPs being more committed to engaging in immunization, with more proactive behavior such as being more likely to immunize when children present for other reasons and regularly raising the issue consultations, hence the association with improved timeliness of vaccinations.

Materials and Methods

The study was part of a larger project which sought to determine the contribution that different health care system factors make to immunization coverage including practice characteristics, knowledge and attitudes of medical and nursing staff towards immunization, parental perceptions of the quality of primary health care received by children less than two years of age and missed opportunities (MOs) for immunization.

The study setting was 124 randomly selected NZ general practices in the Auckland and Midlands regions. Approximately 50% of all NZ children aged 0 to 4 years reside in the study region.[24] General practices were randomly sampled with over sampling of practices with Māori governance. Such practices were established to serve the NZ indigenous population who have a poorer health status including lower immunization rates than the national population.[30-32] Full details of the recruitment process, characteristics of the practices, NZ infant immunization schedule and full definitions of immunization coverage and timeliness have been previously reported.[33,34]

An audit of 661 children from a subgroup of 62 practices was undertaken to explore MOs to vaccinate at the practice level. From 10,094 visits to general practices, MOs occurred in 97% (60) of the practices, with 31% (202) of the children. Eighty percent of these (447) of them occurred with acute care visits, with the most frequent diagnosis being acute respiratory illness in 37% (166 of visits). The MO aspect of the study is reported in depth elsewhere.[35]

Participants. The study setting was the regions of Auckland and Midland, incorporating six District Health Boards. This area covers approximately 66% of NZ's population and has high Maori and Pacific populations. The sample involved 124 randomly selected practices, 72 from the Auckland and 52 from the Midland region. This sample size was sufficient to show statistical significance at the 80% level for a health professional knowledge measure associated with higher immunization coverage if this measure was present in 20 to 25% more of the practices with higher coverage.

Practice coverage and timeliness were measured by an independent electronic audit of each practice's primary care management system. Each practice was visited by a member of the research project team and at this visit the date of birth and immunization records of the children registered at the practice and aged less than two years were downloaded. Coverage and timeliness were calculated for each practice from this dataset.

The percentage of registered children at each practice who had received all of their scheduled immunizations and the percentage that were delayed for any of their scheduled immunizations were described. Practice immunization coverage was defined as the percentage of registered children who had received all of their scheduled immunizations. The third dose assumption was used when estimating this percentage. If the third in a series of vaccine doses was recorded as given then it was assumed that the previous doses had also been given, whether or not they were recorded.[36] This assumption results in a small overestimate of coverage that is considerably less than the underestimate which occurs if only recorded doses are counted.

We used the NZ Immunization Register definition of immunization delay.[37] An immunization was delayed if it had not been received within four weeks of the first due date for the NZ immunization schedule at six weeks of age, and within six weeks for 3 month, 5 month and 15 month immunization events.

A computer-assisted telephone interview (CATI) was conducted with one randomly selected doctor from each practice. The interview included demographics (age, gender, length of time in practice and working hours), views on barriers to immunization, educational

Table 1 **Associations of GP characteristics with immunization coverage at the practice**

Variable (number of practices)	**Median practice immunization coverage (25th, 75th centile)**				**p value***
Region	**Auckland**		**Midland**		
Governance	**Māori n = 7**	**Non-Māori n = 61**	**Māori n = 14**	**Non-Māori n = 36**	
Gender (106)					
Male (71)	28 (20, 36)	69 (63, 77)	58 (46, 62)	78 (73, 82)	**0.06**
Female (35)	41 (24, 58)	71 (65, 75)	60 (56, 65)	74 (57, 79)	
Practice teamwork					
Agrees that practice teamwork is strong (106)					
Yes (27)	36 (36, 36)	75 (67, 81)	57 (49, 71)	74 (57, 82)	0.31
No (79)	24 (20, 58)	69 (62, 76)	58 (46, 62)	75 (73, 80)	
Attended 2 or more practice meetings in past month (103)					
Yes (57)	24 (20, 36)	73 (64, 78)	56 (46, 65)	78 (71, 82)	0.17
No (46)	-[†]	70 (62, 75)	60 (52, 62)	75 (62, 80)	
GP perceptions of barriers to immunization					
Perceives parental access difficulties as a barrier (106)					
Yes (19)	58 (58, 58)	70 (63, 75)	69 (44, 78)	74 (22, 75)	**0.04**
No (87)	24 (20, 36)	70 (61, 77)	56 (46, 59)	77 (70, 82)	
Perceives parental apathy as a barrier (106)					
Yes (70)	36 (29, 58)	67 (52, 75)	55 (36, 63)	75 (71, 81)	0.25
No (36)	24 (24, 24)	74 (68, 80)	59 (56, 62)	75 (61, 79)	
Perceives parental fear as a barrier (106)					
Yes (58)	36 (36, 36)	71 (52, 77)	54 (46, 59)	76 (73, 82)	0.22
No (48)	24 (20, 58)	70 (65, 77)	62 (46, 76)	72 (57, 80)	
Perceives parental ambivalence as a barrier (106)					
Yes (50)	47 (36, 58)	73 (62, 77)	54 (36, 63)	77 (71, 82)	0.59
No (56)	22 (20, 24)	69 (63, 75)	59 (58, 62)	74 (61, 80)	
GP immunization practice and knowledge					
Confident in knowledge about immunization (106)					
Yes (84)	30 (22, 47)	70 (63, 77)	62 (56, 65)	76 (70, 81)	**0.002**
No (22)	-[†]	68 (46, 78)	39 (25, 56)	73 (70, 81)	
Correctly identified the abbreviation 'CARM'[‡] (106)					
Yes (27)	58 (58, 58)	75 (70, 82)	58 (46, 80)	74 (62, 80)	0.09
No (79)	24 (20, 36)	67 (52, 77)	58 (46, 62)	77 (71, 82)	
Spends a long time with 1st time parents on immunization (106)					
Yes (49)	41 (24, 58)	69 (52, 79)	59 (52, 62)	78 (73, 82)	0.92
No (53)	28 (20, 36)	71 (63, 75)	46 (26, 76)	75 (67, 80)	
Refers to immunization hand book monthly or more often (105)					
Yes (37)	28 (20, 36)	63 (49, 71)	59 (56, 76)	79 (62, 83)	0.65
No (68)	41 (24, 58)	75 (67, 79)	49 (46, 62)	75 (71, 80)	
GP contraindication knowledge					
Being treated for leukemia as a reason to delay[§,||] (73)					
Yes (46)	-[†]	72 (67, 75)	62 (59, 65)	75 (73, 81)	**0.01**
No (27)	58 (58, 58)	63 (52, 74)	39 (26, 52)	71 (56, 78)	
Fever is not a contradiction[§] (106)					
Yes (73)	30 (22, 47)	71 (65, 78)	58 (46, 65)	78 (74, 83)	**0.04**
No (33)	-[†]	64 (42, 75)	56 (46, 62)	73 (61, 80)	
Motor delay is a contraindication[¶] (83)					
Yes (17)	24 (24, 24)	69 (52, 73)	58 (24, 62)	79 (74, 79)	0.62
No (66)	28 (20, 36)	70 (63, 78)	62 (59, 65)	75 (70, 82)	

Table 1 **Associations of GP characteristics with immunization coverage at the practice (continued)**

A rash after eating eggs is not a contradiction[||] (81)					
Yes (47)	30 (24, 36)	74 (69, 79)	60 (26, 65)	75 (73, 80)	**<0.001**
No (34)	58 (58, 58)	70 (63, 75)	60 (56, 69)	76 (57, 81)	
Previous prolonged screaming is not a contradiction[¶] (76)					
Yes (54)	24 (20, 58)	70 (62, 78)	59 (52, 65)	76 (67, 81)	0.95
No (22)	-[†]	70 (64, 75)	43 (24, 62)	73 (70, 80)	

*Adjusted for region, practice governance and socioeconomic deprivation of the registered population, age and registration age of children <2 years old. [†]No practices in this category; [‡]CARM = Centre of Adverse Reaction Monitoring; [§]Rather than as not a contraindication or a reason never to immunise the child; [||]With respect to MMR vaccine; [¶]With respect to acellular pertussis vaccine.

Table 2 **Associations of GP characteristics with immunization timeliness at the practice**

Variable (number of practices) **Region** **Governance**	**Median practice immunization coverage (25th, 75th centile)** **Auckland** **Māori** **n = 7**	 **Auckland** **Non-Māori** **n = 62**	 **Midland** **Māori** **n = 14**	 **Midland** **Non-Māori** **n = 37**	**p value***
GP perceptions of barriers to immunization					
Perceives parental access difficulties as a barrier (108)					
Yes (19)	47 (47, 47)	62 (55, 68)	63 (38, 66)	57 (12, 59)	**0.005**
No (89)	23 (17, 32)	56 (44, 67)	40 (25, 45)	61 (47, 64)	
Perceives parental apathy as a barrier (108)					
Yes (71)	32 (23, 47)	58 (44, 66)	35 (25, 55)	60 (47, 63)	0.18
No (37)	17 (17, 17)	65 (48, 68)	45 (43, 52)	59 (47, 65)	
Perceives parental fear as a barrier (108)					
Yes (58)	23 (23, 23)	60 (49, 68)	42 (30, 45)	61 (53, 64)	0.28
No (50)	32 (17, 47)	59 (40, 66)	52 (13, 64)	50 (27, 62)	
GP immunization practice and knowledge					
Confident in knowledge about immunization (108)					
Yes (86)	28 (20, 40)	60 (47, 68)	47 (30, 62)	59 (47, 63)	**0.002**
No (22)	-[†]	55 (39, 63)	33 (19, 42)	55 (47, 62)	
GP contraindication knowledge					
Being treated for leukemia as a reason to delay[§,||] (73)					
Yes (46)	-[†]	63 (55, 67)	50 (43, 62)	61 (50, 63)	**0.05**
No (27)	47 (47, 47)	49 (38, 67)	27 (13, 40)	57 (32, 66)	
Fever is not a contradiction[§] (108)					
Yes (74)	28 (20, 40)	60 (49, 68)	42 (25, 62)	61 (54, 64)	0.09
No (34)	-[†]	50 (35, 65)	45 (30, 52)	56 (47, 63)	

*Adjusted for region, practice governance and socioeconomic deprivation of the registered population, age and registration age of children <2 years old; [†]no practices in this category; [§]rather than as not a contraindication or a reason never to immunise the child; [||]with respect to MMR vaccine; [¶]with respect to acellular pertussis vaccine.

needs, experience, knowledge (contraindications and vaccine safety), attitudes, resources available and education of parents regarding immunization (see Appendix 1 for interview schedule). The interviews lasted about 20 minutes with answers entered directly into the database for collation and analysis. Quantitative responses included yes/no answers, Likert scales and multi-choice options. The CATI was developed using a questionnaire developed in the UK[5] and previously adapted for use in NZ.[19]

Analysis. Analysis was conducted using SAS statistical software. The proportion fully immunized and the proportion with no delayed immunizations were both transformed to facilitate analysis using the arcsin of the square root of the variable. This transformation made the variance constant across the distribution of coverage and timeliness at each practice.

Two general linear models were created with arcsin of the square root of the proportion immunized and the proportion with no immunization delay as the respective outcome variables. Univariate associations of GP characteristic variables with practice immunization coverage and timeliness were determined. Within the statistical models created for coverage and the timeliness each variable was examined for interaction with either region (Auckland and Midland) or practice governance (whether or not Māori governance). Variables for which such interaction was present were not included in the analysis.

Table 3 Multivariate analysis of GP association with practice immunization coverage and timeliness

	Association with coverage	Association with timeliness
R-squared for model	0.54	0.39
Number of practices in model	98	100
Region	<0.0001	0.102
Social deprivation	<0.0001	<0.001
Age as a continuous variable	<0.0001	NS
Māori governance	0.039	0.056
GP knowledge (re fever)	**0.018**	NS
GP confidence in knowledge	**0.038**	NS
GP perceives parental access difficulties as a barrier	NS	**0.018**

NS = Not significant.

Associations of GP characteristics with coverage and timeliness were then examined in a multivariate model that included variables describing social deprivation, age of the registered children at each practice, practice region and practice governance. Practice, practice nurse and caregiver characteristics were also included in the multivariate model but are not reported here. Statistical significance was defined as a p value <0.05.

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Appendix 1

CATI Questionnaire to General Practitioners on Immunization

Survey ID

Practice ID

Start time of this call

Date of this call

Practice name

Practice phone number

Call record codes (E = engaged, N = no reply, O = respondent out, C = call back requested by respondent, I = interview obtained, R = interview refused, D = dropout)

Could you please tell me how many GPs there are in this practice?

Could you tell me the surnames of the GPs in this practice excluding any locums?

Respondent's name

Date to call back

Time to call back

Preferred contact phone number and fax number

E-mail address

GP Organizations

Do you belong to an IPA? (Y/N)

(15a) If yes, does the IPA offer other support for your immunization services?

(15b) What are they?

Do you belong to a PHO? (Y/N)

(16a) If yes, does the PHO offer other support for your immunization services?

(16b) What are they?

Barriers

I'm going to read out several statements that have been made about barriers to immunization.

Using a scale of 1 to 5, I'd like you to rate how much you perceive each to be a barrier to improving immunization, what 1 is totally agree, 5 is totally disagree, and 3 is neither agree nor disagree.

Patient difficulties in accessing services

Parental fear regarding immunization

Lack of funding for providers

Lack of time for providers to offer services

Lack of knowledge in health professionals

Poor Ministry direction

Lack of interest in the topic by providers

What other barriers to immunization are there that we haven't covered?

GPs' Educational Needs

We'd like some feedback from you regarding various GP educational needs from the GP's viewpoint. I'm going to read out a list of areas what we have previously been asked to provide information on.

Would you personally like more information regarding these areas of immunization? (Y/N)

- *Knowledge of the vaccines*
- *Knowledge about vaccine side effects*
- *Knowledge about the New Zealand immunization schedule and rationale behind it*
- *Knowledge of the diseases*
- *Knowledge about delivery techniques for vaccines*
- *Support with methods for obtaining informed consent, and answering parental concerns*
- *New vaccines*
- *Current issues reported in the media*
- *What other areas on immunization would you like information about?*
- *GPs Educational Resources*

The next group of questions will cover several aspects of your experience and knowledge of immunization, the resources available regarding immunization, and imparting your knowledge of immunization to parents.

From which of these places do you go to get more information regarding immunization?

- *The IMAC newsletter, sometimes known as "immunize to protect"*
- *Latest copy of Immunization Handbook*
- *0800 IMMUNE number*
- *Immunization Facilitator*
- *Childhood immunization booklet (describe pictures on cover if there is confusion)*
- *Well Child book*
- *Medical Officer of Health, for*

(A): Advice around the childhood schedule for vaccination

(B): Notification regarding vaccine preventable diseases

- *Colleague (Other PN, GP, etc.,)*
- *CME (Continuing Medical Education)*

Do you use the Internet for information around the childhood schedule?

Which other sites do you use:

- *MOH website*
- *CME website*
- *IMAC website*
- *IAS website*
- *Other*

Where else do you go for information?

GPs Knowledge and Attitudes

In this section we will be discussing specific information regarding contraindications and vaccine safety.

- *What is the temperature range for storing national vaccines?*
- *How do you diagnose measles?*
- *What other methods do you use to diagnose measles?*
- *What procedure do you use to notify any of the vaccine preventable diseases?*
- *What other procedures do you use to notify preventable diseases?*
- *What does CARM stand for?*
- *Who in the practice notify CARM on behalf of the practice?*
- *Which method does your practice mainly use to notify CARM?*
- *Under what circumstances would your practice notify CARM of an adverse vaccine reaction?*

Contraindications

Do you consider the following to be contraindications to MMR vaccine in a child?

The responses are A = Yes; B = Yes and delay immunization; C = No, not a contraindication; D = Don't know)

- *Baby had febrile convulsion at 11 months*
- *Sibling has ADHD or Autism*
- *Baby has spina bifida and hydrocephalus*
- *Baby gets a rash eating eggs*
- *Baby being treated for leukaemia*
- *Baby has eczema*
- *History of parental febrile fits?*
- *Baby with snuffly cold (runny nose, low-grade fever)*
- *Baby reported to have had measles*
- *Mother pregnant*
- *Mother breastfeeding*

Do you consider the following contraindications to pertussis vaccination?

- *Screaming for more than three hours after the previous immunization*
- *Bay has apnoea in first three weeks*
- *Baby has a nasal discharge*
- *Baby has spina bifida, no leg weakness*
- *Older sibling had fever following DtaP (Diptheria, tetanus and acelleair pertussis vaccine, not polio)*
- *History of parental febrile fits*
- *Sibling has eczema or asthma*
- *Baby has motor delay*
- *Baby has eczema*
- *Baby has had a HHE (Hypotonic Hyporesponsive Episode) following previous immunizations*

Do you consider six weeks too young to immunize babies?

What would you say the minimum age should be?

GPs' Practices Regarding Immunization

The next section covers the way you educate parents regarding immunization

Who usually obtains informed consent?

Who is the usual deliverer of the actual immunization?

On what other occasions would you personally give immunization information to:

(A) Parents?

(B) Pregnant women?

(C) Possible contraindications?

On what other occasions would you give immunization information to parents?

When providing information to parents, which method do you usually use to impart the information?

(A = verbal, B = written, C = both, D = a GP does it)

How long would you spend talking to first time parents on average?

(<2 mins, <5 mins, 5–10 mins, 10–20 mins, 20+ mins)

How long would you spend talking with parents of multiparity?

Demographics

Now we are on to the demographic portion of the survey.

Could you please tell me your age band?

(A = under 23 years, B = 23–29 years, C = 30–39 years, D = 40–49 years, E = 50–59 years, F = 60+ years)

How long have you been practicing as a GP?

(A = under 5 years, B = 5–9 years, C = 10–19 years, D = 20+ years)

Are you working full-time (8/10 or more) *or part-time* (less than 8/10)?

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Family practice nurse views on barriers to immunising children

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Abstract

New Zealand (NZ) has low immunisation coverage for infants and children compared to many other westernised countries. Barriers to improving uptake are multifactorial, with health professional knowledge and attitudes identified as important modifiable factors. In NZ practice nurses give most childhood vaccinations in the primary health care setting. This study explored aspects of 150 family practice nurse views, knowledge and experience about immunisation. Qualitative and quantitative text data were obtained through randomised computer assisted telephone surveys and converged using a triangulated multi-method approach. Response rate was 89.3% nurses identified parents' fear as the greatest barrier to achieving better immunisation uptake and disagreed that health professional knowledge was a barrier. However, findings showed lack of knowledge among many participants, despite many feeling confident about their knowledge base. Factors associated with lower practice coverage of infants under 2 years were poorer knowledge of contraindications to vaccination and lack of completion of vaccinator training, especially an update course. A high level of confidence, more years in practice, dedicated time to follow-ups were not associated with better coverage rates. Practice nurses may be unaware that their knowledge in some areas needs improving. A trained practice nurse appears to play a significant role in overcoming fears and maintaining high coverage rates in their practice. We conclude that strategies that focus on primary health care provider support and education are more likely to gain high coverage than those that are purely directed at overcoming access barriers.

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Keywords: Immunization; Primary health care; Nurses; Communication

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1. Introduction

Childhood immunisation coverage in New Zealand (NZ) is lower than in many other westernised countries and in its Pacific neighbours. UNICEF 1998 data indicated that NZ was ranked 102nd out of the 193 listed countries for its primary infant series immunisation rates [1]. In response to the current low rates, NZ has introduced a number of initiatives. These include the development of a register to track children's immunisation status, and increasing availability of outreach services.

The NZ situation contrasts with developments in Australia and the United States, both of which have recorded improved immunisation rates in recent years. These changes have been achieved by the use of a combination of approaches [2,3]. In both countries an increased emphasis on supporting providers and communicating vaccine safety issues has been a major component of their improved coverage strategy.

The knowledge of nurses, physicians and other health providers about immunisation and their ability to clearly communicate risk-benefit information to parents has been identified as one of the most important factors in vaccine uptake [4–7]. There is an active anti-immunisation lobby in NZ [8] and while there has been national and local efforts to provide accurate immunisation messages to the public, it is evident that the activities of the lobby group contribute to the erosion of public confidence [9]. Recent research indicates that

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many NZ parents have low confidence in immunisation, and vaccine safety is a primary concern [10]. Access to health care services also is consistently highlighted as a major issue, particularly for parents from the lower socio-economic groups. However, evidence indicates that parental fear and active decisions not to vaccinate is in itself sufficiently high to prevent achieving the 95% target uptake rate [11]. The ability of some local primary health care initiatives to overcome the poor national coverage rates and consistently obtain coverage rates for their populations over 90% demonstrates that well integrated primary health care services with committed health professionals can make considerable difference, even without addressing the access issues with outreach services [12].

The immunisation programme for NZ infants is delivered within the primary health care setting. NZ research supports the interpersonal relationship with the health professional as being the one in which the parents have confidence and trust [13]. In contrast the other education avenues such as Ministry of Health brochures or information from pharmaceutical companies can be held in considerable suspicion [13].

In NZ family practice, family physicians (general practitioners) and practice nurses work as a team. In most practices the doctor's primary role is to educate parents about immunisation issues, and to opportunistically encourage them to have their children vaccinated when they present for other health reasons. Only in a small minority of practices do doctors actively administer vaccines. The practice nurse's role generally involves not only parental education, but all aspects of immunisation delivery including ordering, safely storing (with documented evidence of maintenance of the cold chain) and administering vaccines to children, as well as maintaining a recall system for all children registered with the practice. In group practices with two or more doctors and nurses, there is usually at least one practice nurse who is likely to have attended one of the nationally standardised vaccinator training courses, which include two-yearly updates. A small number of sole family physician practices do not employ practices nurses (7% of all practices) [14] and in these cases the doctor assumes all responsibility for immunisation administration.

The aim of this study was to understand the immunisation issues confronting practice nurses in NZ using a national randomised computer-assisted telephone survey. The questions focused on general practice organisation issues; nurse perceptions of barriers to improving immunisation; their knowledge and educational needs regarding immunisation; preferred resources, and their own practices around immunisation. This study was conducted contemporaneously with a similar survey of NZ family physicians [14].

2. Methods

Both quantitative and qualitative text data were obtained through computer-assisted telephone surveys. These data were converged using a triangulation, multimethod approach to understand immunisation issues confronting practice nurses.

2.1. Sample population

The study was conducted between July 2002 and January 2003. The subjects were practice nurses working in family practices throughout NZ. A list of 1283 national family practices was obtained from a commercial vendor, the most comprehensive and reliably updated database available to NZ researchers. The interviewer was supplied with a list of computer generated randomly selected practices and continued contacting practices in the order provided until 150 nurses had been recruited to the study. The inclusion criterion was any immunising practice nurse working at the practice either part or full-time. All practices carrying out childhood immunisations were considered eligible. In practices with more than one practice nurse, the interviewer spoke to the nurse primarily responsible for administering vaccines, with a request to participate in the survey. Exclusion criteria were non-vaccinating practices included in the commercial vendor's list (family planning clinics; some accident and medical centres; sports medicine practices); agency (locum) nurses or practices without a practice nurse.

The sample size of 150 is justified by sample size calculation using EpiInfo 2000. For a population of approximately 3211 NZ practice nurses (1600 full time) with an expected frequency of 53% of health professionals who would know that egg allergy is not a contraindication to MMR vaccination (based on international literature [4]) ±8%, and to get 95% confidence level, a sample of 143 people is needed. The precision of the estimate was assessed by using standard error and 95% confidence interval, which is acceptably small (±8% with a potential of further reduction for situations where expected frequency is lower than 47%).

Approval for the study was obtained from the University of Auckland Human Ethics Committee.

2.2. Questionnaire design

The design of the questionnaire was based on areas identified in the literature as barriers to immunisation. It also explored nurses' educational needs and preferred sources for immunisation information, their confidence and their knowledge [10,15].

2.3. Data collection

A computer-assisted telephone survey tool that managed the sample and questions facilitated interviewing. The interview lasted about 20 min with answers entered directly into the database for collation and analysis. Quantitative responses included yes/no answers, Likert scales, multi-choice options and demographic data including age, gender and nature, duration in, and location of, practice.

Qualitative data involved free-form answers to questions including other perceived barriers to immunisation, sources of information about immunisation and identification of adverse reactions requiring notification to the national passive reporting system—the Centre for Adverse Reactions Monitoring (CARM).

2.4. Data analysis

Quantitative data analysis was conducted using EpiInfo 2000 where differences between groups were sought. Cross tabulations were carried out to determine differences between age groups; years in practice; urban versus rural and responses to some of the key areas.

Free-form data response analysis used a general inductive approach. Individual text responses were initially analysed to identify sub-themes. The data was then collated and analysed for emerging categories. These were combined into major themes through ongoing discussions and re-reading of the data by the first two authors until consensus was reached regarding the main themes being expressed. Where applicable, codes previously used for family physician responses to the same questions were utilised. The data were independently double-coded as a consistency check with discrepancies resolved by adjudication. Themes were determined and combined through discussions between two of the researchers (H P-H and F G-S) until consensus was reached.

3. Results

3.1. Response rate

A total of 199 randomly selected practices were contacted to reach a sample of 150 nurse participants. Thirty-one practices did not meet the inclusion criteria. The active participation rate of eligible nurses was 89.3% (150/168). Of the 18 nurses who did not complete the survey, five declined and 12 requested the researcher to call back but a suitable time for interview was unable to be scheduled within the study period.

All but two of the practice nurses were female (98.7%) and the majority (78%) were aged 40 years or older. However, 84 (56%) had been in practice less than 10 years, indicating a relatively late onset to this vocation. Fifty percent worked part-time (less than eight-tenths) and 87 (58%) had pre-school or school-aged children.

3.2. Barriers to immunisation

Table 1 presents the nurses' responses to a list of possible barriers to child immunisation perceived by practice nurses, with parental fear (68.7%) emerging as the major factor. Access to services was not seen as a substantial barrier by either urban or rural nurses. When their responses to the open-ended question on barriers to immunisation were analysed, the strongest theme to emerge was parents' lack of information, or misinformation regarding immunisation, especially that received from their attending midwives. Many also identified cultural and language factors, both with indigenous Māori and also with Pacific Island and Asian immigrant populations. Parental apathy ('*They never get around to it.*') was an identified barrier. There was strong support for a national immunisation register to follow-up transient families.

3.3. Practice nurse knowledge

To test their knowledge, participating practice nurses were asked about their considerations on contraindications to the measles/mumps/rubella (MMR) and pertussis vaccinations (Table 2). The nurses were categorised into those who had completed vaccinator training within 2 years and those who had trained more than 2 years ago or not at all. Whether the course was a base course or an update course was noted. Their mean number of correct answers to questions regarding contraindications for MMR and pertussis vaccines indicated that those who had received training over 2 years prior to the survey, or had never attended a course, were significantly less likely to give correct responses (Bartlett's $\chi^2 = 7.1077$, 1 d.f., $p = 0.0077$). When the type of course attended was analysed those that had attended an update course rather than a base course scored significantly better ($\chi^2 = 4.79$, $p = 0.029$).

When the nurses were categorised according to the vaccine coverage rates within their child patient population, those with the highest coverage rate (≥95%) had a significantly higher mean number of correct answers than those with the lowest coverage rate (<70%) (Bartlett's test $p = 0.0034$).

Nearly a quarter of participants believed that fully breastfed babies either always or sometimes receive specific protection against pertussis 35 (23.3%) and 10 (7%) believed fully

Table 1
Practice nurses' perceived barriers to improving immunisation ($N = 150$)

Barrier	Agree, *n* (%)	Neither agree nor disagree, *n* (%)	Disagree, *N* (%)
Parental fear regarding immunisation	103 (68.7)	17 (11.3)	30 (20.0)
Lack of funding for providers	31 (20.6)	11 (7.3)	108 (72.0)
Lack of time for providers to offer services	24 (16.0)	10 (6.7)	116 (77.3)
Patient difficulties accessing services	22 (14.7)	11 (7.3)	138 (92.0)
Lack of knowledge in health professionals	7 (4.7)	5 (3.3)	117 (78.0)
Lack of interest in the topic by providers	4 (2.7)	6 (4.0)	140 (93.3)
Poor Ministry of Health direction	4 (2.7)	6 (4.0)	140 (93.3)

Table 2
Practice nurse perceived contraindications to MMR and pertussis vaccinations ($N = 150$)

	Correct answer	
	n	Rate (%)
Perceived contraindication to MMR vaccination		
Baby being treated for leukaemia*	50	33.3
Baby gets a rash eating eggs	65	43.3
Baby has spina bifida and hydrocephalus	84	56.0
Mother pregnant	114	76.0
Baby had a febrile convulsion at 11 months	119	79.3
Baby with snuffly cold	122	81.3
Baby reported to have had measles	123	82.0
Sibling has ADHD, Autism or Aspersers	128	85.3
History of parental febrile fits	129	86.0
Mother breastfeeding	140	93.3
Baby has eczema	142	94.7
Perceived contraindication to pertussis vaccination		
Baby had an HHE following previous immunisation	25	16.7
Screaming for more than 3 h after the previous immunisation	39	26.0
Baby had apnoea in first 3 weeks	92	61.3
Baby has spina bifida, no leg weakness	103	68.7
Baby has motor delay*	109	72.7
Baby has a nasal discharge	116	77.3
Other sibling had fever following DTaP	146	97.3
History of parental febrile fits	141	94.0
Baby has eczema	141	94.0
Sibling has eczema or asthma	148	98.7

Actual contraindications to immunisation. Key—ADHD: attention deficit hyperactivity disorder; HHE: hypotonic hyporesponsive episode; DTaP: diphtheria, tetanus and acellular pertussis vaccine.

breastfed infants received specific protection against measles. There appeared to be some level of concern about the age at which infants are first immunised with 12 (8%) considering the scheduled 6 weeks as too young and 20 (13.3%) considering that this was sometimes so. The preferred ages were 8 weeks ($n = 9$), 10 weeks ($n = 8$), 12 weeks ($n = 13$) and other ($n = 2$).

Further analysis of practices nurses who scored less than 14/21 (67%) correct responses to the knowledge questions was conducted. This score was selected because 70% is the pass mark for vaccinator training courses in NZ. There were 50 participants (33% of the total sample) in this group. Of these 50, 30 (60%) said that they did not need more knowledge on vaccine side effects. Furthermore, 14 (28%) said that they were very comfortable, 26 (52%) were comfortable and 10 (20%) were neither comfortable nor uncomfortable about their knowledge of immunisation, with none slightly uncomfortable or not comfortable about their knowledge of immunisation.

3.4. *Practice nurse confidence*

To explore whether confidence influenced vaccine coverage, all participants were categorised into two groups according to their level of confidence regarding their knowledge of immunisation. One hundred and twenty-seven nurses were very comfortable or comfortable about their knowledge on immunisation and 23 nurses were neither comfortable nor uncomfortable about their immunisation knowledge. Nurses with immunisation coverage <90% and ≥90% were compared. No statistical significance was found between the two groups ($\chi^2 = 0.06$, $p = 0.813$).

3.5. *Information resources*

All respondents cited the Ministry of Health Immunisation Handbook as a source of further information on immunisation and 93% used their local immunisation coordinator/district immunisation facilitator. Over all, practice nurses use a range of sources to get further information including other Ministry leaflets and booklets, colleagues and the university-based National Immunisation Advisory Centre services.

3.6. *Practice nurse educational needs*

When presented with list of various educational needs (Table 3), those identified by the nurses as most important were information on current issues reported in the media, for example anthrax and bio-terrorism, or the relationship between MMR and autism ($n = 99$; 66%) and information on new vaccines ($n = 73$; 48.7%).

From the qualitative analysis of their responses to other immunisation related information they would like, the major (most frequently raised) theme to emerge was the need for resources to counter misinformation on immunisation and to clearly present relative benefits and risks (‘*Accurate information to hand to parents disproving the myths.*’). A number also expressed the need for easy access to immunisation sched-

Table 3
Educational needs identified by nurses

Area of knowledge	Yes, *n*	Yes, %
Current issues reported in the media	99	66.0
New vaccines	73	48.7
Support with methods for obtaining informed consent, and answering parental concerns	59	39.3
Knowledge of the vaccines	44	29.3
Knowledge around vaccine side-effects	41	27.3
Knowledge around the NZ immunisation schedule, and rationale behind it	32	21.3
Knowledge of the diseases	27	18.0
Knowledge around delivery techniques	24	16.0

ules from other countries, to better facilitate immunisation updates for immigrant families.

The health professionals we have surveyed tend not to view their own lack of knowledge as a barrier to immunisation coverage. The nurses held a similar view to the doctors previously surveyed [14] regarding the statement that ‘lack of knowledge in health professionals was a barrier to immunisation’. Most participants (138; 92%) disagreed with this statement with 98 (65%) totally disagreeing. This idea was more likely to be held by younger nurses, under 40 years ($\chi^2 = 5.56$, $p = 0.0184$).

3.7. *Response to adverse reactions*

The nurses were also asked under what conditions they thought would warrant notification to CARM, NZ’s passive reporting system. Twenty percent ($n = 30$) indicated that they would notify even mild local reactions (for example, ‘*Every reaction however small.*’) although the Immunisation Handbook advises that only unexpected or serious adverse events following immunisation should be reported [16]. However, very few (18; 12%) had ever experienced a serious reaction. Of these events, four were anaphylaxis; seven were a child ‘*going floppy*’ (probable hypotonic hypo-responsive episode), one was post-vaccine encephalitis and three were cases of inconsolable crying. One reported fainting in an 11-year old as a ‘*serious adverse reaction*’.

4. Discussion

This is the first comprehensive survey of NZ family practice nurses on their views on barriers to immunisation, their knowledge and their reported responses to adverse events. These nurses are the primary vaccinators of children in New Zealand.

The views of practice nurses is in accordance with studies of family physicians and of parents themselves, showing that parental concerns over vaccination safety is the most significant barrier to immunisation. The nurses strongly identified a need for resources to help address misinformation that is often accessed by parents, to provide balanced information about the risks and benefits of immunisation to assist parents’ confidence in their decision to vaccinate their children.

Many of the nurses themselves demonstrated lack of knowledge with respect to the safety of vaccines, with a significant minority incorrectly identifying presented conditions as contra-indications. International literature shows that poor knowledge of immunisation by health professionals, rather than attitudes, is the single biggest factor in vaccine uptake [4,6,17,18]. This was borne out by the findings that the more recently trained nurses and those with the best practice coverage rates were more likely to give correct response to the questions on contra-indications to vaccination. Only 27–29% indicated they would like more knowledge about the vaccines and their side-effects but clearly their responses indicate an overly cautious approach in which opportunities to vaccinate will be missed.

The nurses’ confidence in their own knowledge of immunisation was neither an indicator of their actual knowledge nor practice coverage rate, and a significant proportion of those with poor knowledge were confident.

Over 20% of participants believed that 6 weeks could be too young to immunise babies. As small babies are most vulnerable to the serious sequelae of disease, in particular pertussis, this is concerning.

There was little significance between recent completion of a vaccinator-training course and a poor versus good knowledge of contraindications to vaccination. The reasons for this may be firstly that the survey was not an open book test, unlike the initial training course; secondly that the method of conveying vaccine contraindications in training may need to be reviewed, or thirdly, that training has little influence on knowledge of vaccine contraindications.

A number of nurses indicated that they would report minor vaccination reactions as adverse events to CARM. It was of interest to note that very few of these 150 practice nurses had ever reported experiencing an adverse reaction that concerned them in any of the children they had vaccinated.

A recent study of the knowledge and attitudes of NZ mothers around immunisation [10] found an underlying fear of vaccines and their perceived side-effects across socioeconomic groups, including both parents who do vaccinate their children as well as decliners to immunisation [19]. Despite these consistent findings, current NZ strategies to improve immunisation uptake predominantly focus on structural barriers to accessing services [20].

Current vaccinator training appears to have a significant impact on immunisation coverage rate in the practice. However, it is not significantly correlated with a better knowledge of contraindications to vaccination in cases of the poorest scores on knowledge. These findings support the importance of ongoing vaccinator training as an effective tool for improving coverage, and a greater focus in these courses on vaccine contraindications may further improve this. In NZ vaccinating practice nurses are required to complete an initial 2-day vaccinator training course with an open book examination. They are then required to complete update courses every 2 years, which are not examined. The results of this study will be incorporated into the national vaccinator training programme to ensure that deficiencies in knowledge relating to contraindications are addressed. Consideration will be given to testing knowledge on contraindications during the update courses.

As parental fears and low confidence appear to be the major concern in the NZ population, a trained practice nurse appears to play a significant role in overcoming fears and maintaining high coverage rates in their practice. Strategies that focus on primary health care provider support and education therefore are more likely to gain higher coverage than those that are purely directed at overcoming access barriers.

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Nurses make a difference in immunisation service delivery

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KEY WORDS

Vaccination; immunisation; family practice; primary health care; primary health care nurse

ABSTRACT

Objective
The study aimed to determine nurse characteristics associated with childhood immunisation coverage and timeliness in the New Zealand primary care setting.

Design
In 2005-2006 a survey of randomly selected practices and health providers was conducted, with multiple regression analysis to establish significant determinants of coverage and timeliness. The multivariate analysis adjusted for social deprivation, region, practice governance and the age of the children registered at each enrolled practice.

Setting
The study was conducted in family practices in two regions in New Zealand, where approximately 66% of the national population reside.

Subjects
One hundred and fifteen practice nurses employed in the primary care setting.

Main Outcome Measures
Nurse characteristics, knowledge and attitudes associated with immunisation.

Results
Immunisations were delivered by 95% of practice nurses. Factors associated with higher practice immunisation coverage and less delay were a lower ratio of nurses to children - in the practice (1:1 to 1:74 (85)1:75 to 1:1290 (30) coverage $P=0.04$, timeliness $P=0.03$), nurse comfort with their own immunisation knowledge (Yes (105), No (4) coverage $P<0.001$, timeliness $P=0.01$) and their perception of parental apathy (Yes (56) No (53) coverage $P=0.01$, timeliness $P=0.02$), or fear (Yes (66) No (43) coverage $P=0.01$), as a barrier to immunisation.

Conclusion
Higher coverage and more timely immunisation delivery is achieved at practices where the nurse to child ratio is lower, where nurses are confident in their immunisation knowledge and are perceptive of parental attitudes which can be barriers to immunisation.

INTRODUCTION

New Zealand (NZ) experiences outbreaks of vaccine preventable diseases as a result of mediocre immunisation coverage (Ministry of Health 2007). Infant pertussis hospital admissions in NZ are 3-6 times those in the United Kingdom (UK), United States (USA) and Australia (Grant et al 2003).

Improving the uptake and timeliness of immunisations are necessary to make gains in disease prevention. There is strong evidence for the use of provider level strategies to improve immunisation coverage (Briss et al 2000, Shefer et al 2001).

Contraindications to vaccinations are well documented (Ministry of Health 2006). However, there are significant grey areas and myths that influence a provider's recommendations. It has been shown that in 34-80% of cases where children attend a clinic and do not receive appropriate vaccines it was due to professionals misapplying contraindications, or missed opportunities (Gamertsfelder DA et al 1994, Mafi et al 2002).

Health professional recommendation has been closely related to vaccine uptake (Gustafson and Skowronski 2005). Trusted professionals can regain parental confidence after exposure to anti-immunisation rhetoric (Leask et al 2006).

It has been estimated that NZ nurses administer 93% of all immunisations given in the practice setting (Petousis-Harris et al 2004) and 80% of practice nurses administer immunisations independently without doctor referral (Kent et al 2005). Considering this level of responsibility, there is a surprising paucity of published, critical assessment of the nurse contribution to immunisation uptake.

Evolution of the practice nurse role has been described as 'changed from that of an administrator needing a few nursing skills, to a nurse needing a few administrative skills' (Halcomb et al 2004). NZ, the UK and Australia are implementing policies to strengthen service delivery in primary care including enhancing the practice nurse role (Halcomb et al 2004, Ross et al 1994).

The aim of this study was to explore characteristics, behaviours, attitudes and knowledge of nurses working in the general practice setting that may influence the completeness and timeliness of childhood immunisations.

METHOD

This study was part of a broader project that sought to determine the relative contribution that health care system factors make to immunisation coverage and timeliness, including practice characteristics (Grant et al 2009), knowledge and attitudes of medical (Goodyear-Smith et al 2009) and nursing staff and parental perceptions of the quality of care received by children less than two years of age and missed opportunities for immunisation (Turner et al 2009). The design was a survey of randomly selected practices and health providers, with multiple regression analysis to establish significant determinants of coverage and timeliness. This paper reports on the contribution of nursing to these determinants.

The study was conducted 2005 to 2006 in family practices in two regions in NZ, in which approximately 66% of the national population reside.

Participants

The sample involved 124 randomly selected practices, 72 from the Auckland region and 52 from the Midlands region. A random sample of practices with stratification by region and over-sampling of Māori governance practices (independent Māori health providers which target services primarily towards Māori and have a Māori management and governance structure) were recruited (Ministry of Health 2004a). Māori governance practices are focussed on improving health care delivery to NZ's indigenous Māori population. Māori children have lower immunisation coverage and higher rates of vaccine preventable diseases (Ministry of Health 2006, Somerville et al 2007).

The sample size calculations estimated that a sample of 125 practices was sufficient to yield 80% power to show statistical significance at the 5% level for a health professional characteristic associated with higher immunisation coverage or more timely immunisation if this characteristic was present in 20 to 25% more of the practices with higher coverage.

Data collection

Practice coverage was measured by electronic audit of each practice's primary care management system. The measure of immunisation coverage used, was the proportion of the registered children at each practice who had received all of their scheduled immunisations. The measure of timeliness, was the proportion of children who were not delayed for any of their immunisations. An immunisation was defined as delayed if it had not been received within four weeks of the first due date for the six week immunisations and within six weeks for the three, five and 15 month immunisations (Ministry of Health 2004b).

Coverage estimate was based on the third dose assumption where if the third dose in a series of vaccine doses has been recorded as being given, then the previous two doses are assumed to have been received, whether or not they are recorded. Such an assumption results in a small overestimate of coverage but this is of a smaller magnitude than the underestimation of coverage that results if this assumption is not use (Hull et al 2003).

Knowledge and attitudes of nurses were elicited using a computer assisted telephone interview (CATI) with one randomly selected nurse from each practice. Nurse knowledge and attitudes were measured using a questionnaire previously used in NZ (Petousis-Harris et al 2005) adapted from a UK questionnaire (Peckham et al 1989).

The nurse survey measured practice nurse characteristics, immunisation practices, knowledge and attitude towards immunisation, the barriers practice nurses perceived to improving immunisation, their attendance at professional immunisation education courses, their sources of immunisation information and areas about which they would like more information or support.

Ethical considerations

Ethics approval was obtained from the Regional Ethics Committee. Participants were provided with information sheets which guaranteed their confidentiality and written consent was obtained.

Analysis

The distribution of variables across practices was determined and where necessary summarised to enable statistical analysis. Nurse characteristics, knowledge and attitudes were defined at the practice level. Descriptive analyses were performed, of immunisation coverage and timeliness, and of the variables describing nurse characteristics, knowledge and attitudes. Regression analysis was used to determine associations of each of the nurse variables with practice immunisation coverage and timeliness. These associations were adjusted for region (Midland and Auckland), practice governance (Māori and non-Māori governance) and for the social deprivation of population registered at each practice. Social deprivation was measured using the 2001 NZ index of social deprivation which divides households in New Zealand into 10 socioeconomic deprivation deciles (Salmond and Crampton 2002). For the multivariate models of nurse determinants of immunisation coverage and timeliness a base model was created that included region, practice governance, socioeconomic deprivation, and the median age of the children registered at each practice. To this base model were added the variables describing nurse characteristics that were identified as potentially important based upon previous published research and upon the results of the univariate analyses. The regression analyses were performed in SAS-PC 9.1 using proc GLM (General Linear modelling) (SAS Institute, Cary, NC, USA).

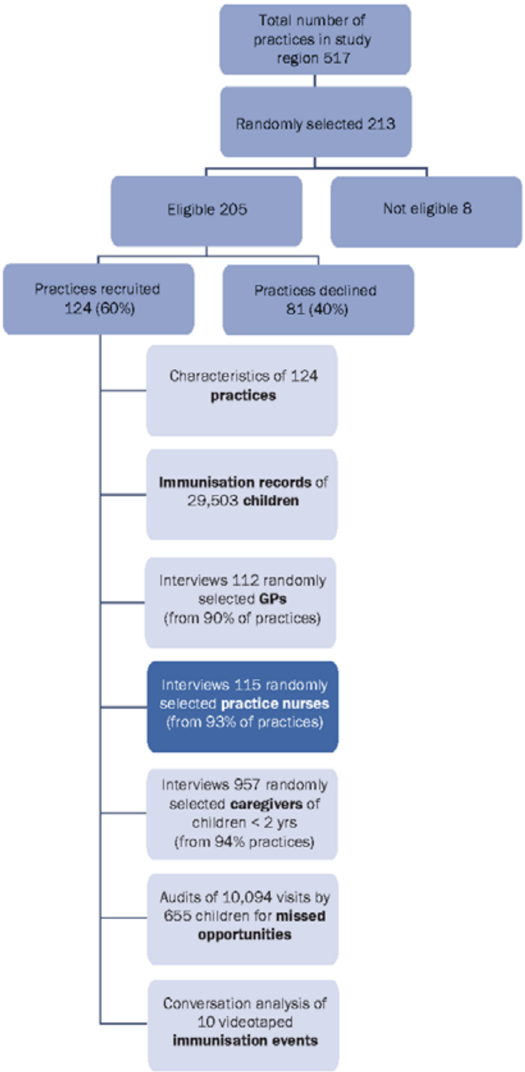
FINDINGS

Participant characteristics

There were 517 practices in the study region. Two hundred and thirteen (41%) were randomly selected, 108 (31%) in Auckland and 105 (61%) in Midland. A small number of practices were ineligible; mainly because they did not provide well-child care and 39% of selected practices declined to participate. The percentage of practices that declined was higher in Midland than Auckland (45% versus 30%, P=0.015)

One nurse from each of 115 of the 124 enrolled practices was interviewed (figure 1). From the full practice sample, four practices did not have nurses and two nurses covered two practices each. Nurses from three practices declined to participate.

Figure 1: Summary of data sets in overall study


Total number of practices in study region 517
Randomly selected 213
Eligible 205
Not eligible 8
Practices recruited 124 (60%)
Practices declined 81 (40%)
Characteristics of 124 practices
Immunisation records of 29,503 children
Interviews 112 randomly selected GPs (from 90% of practices)
Interviews 115 randomly selected practice nurses (from 93% of practices)
Interviews 957 randomly selected caregivers of children < 2 yrs (from 94% practices)
Audits of 10,094 visits by 655 children for missed opportunities
Conversation analysis of 10 videotaped immunisation events

Sixty-seven nurses were from practices in Auckland and 48 from the Midland region. All were female. The majority of the nurses were aged 40 and over (n=79/115, 69%) and 47/115 (41%) had been working as practice nurses for 10 to 19 years. This is representative of NZ primary health care nurses (Ministry of Health 2003b).

The number of registered children under the age of two per nurse full time equivalent (FTE) varied widely across the 124 practices ranging from 0 to 290 children (mean=60) per nurse FTE. Seventy two (63%) of the nurses had dedicated time for immunisation follow-up and most (109/115; 95%) were exclusively responsible for delivery of immunisations.

Nurses' preferred source of information (n=111/115; 97%) was the Ministry of Health Immunisation Handbook. Most nurses (n=100/115; 87%) sought further information from practice nurse colleagues and 89/115 (77%) would go to GP colleagues for information. The most frequently requested information was that relevant to current issues in the media (n=89/115; 77%).

The majority of nurses (100/109; 96%) felt comfortable with their immunisation knowledge. Despite this, significant gaps were shown. With respect to contraindications to measles, mumps, rubella (MMR) vaccine, 61/115 (53%) correctly identified that a rash after eating eggs was not a contraindication to MMR immunisation, 23/115 (20%) stated they would delay MMR if the child had rhinorrhoea and low grade fever.

Nurses' opinions varied considerably on barriers to patients accessing services. Parental apathy or ambivalence was considered a barrier by 58 (47%) and parental fear by 68/109 (59%). The following factors were not identified as significant barriers: poor Ministry of Health direction (n=72/115; 62%) lack of provider funding (n=87/115; 76%), time (n=83/115; 72%) or provider knowledge (n=92/115; 80%). Of the 77 nurses who offered other suggestions, 22 (30%) considered anti-immunisation misinformation to be a significant barrier for parents.

Nurse characteristics associated with coverage and timeliness

After adjustment for region, Māori governance, social deprivation of the practice population and median age of the children registered at each practice, higher practice immunisation coverage was associated with: a lower ratio of nurses to children registered with the practice (*P*=0.03), nurse perception of increased parental apathy (*P*=0.005) or fear (*P*=0.008) as a barrier and her comfort in her knowledge about immunisation (*P*=0.0004) (table 1).

Table 1: Significant associations of practice nurse characteristics with immunisation coverage at the practice

Variable (number of practices)	**Median practice immunisation coverage % (25th, 75th centile)**				
Region	***Auckland***		***Midland***		
Governance	Māori n=7	Non-Māori n=61	Māori n=14	Non-Māori n=36	*p* value*
Practice infrastructure relevant to delivery by nurses					
Ratio of practice nurses to children (115)					
1:1 to 1:74 (85)	51% (36,64)	73% (64, 77)	58% (46, 63)	75% (71, 82)	*p*=0.03
1:75 to 1:1290 (30)	24% (24, 24)	67% (52, 71)	49% (47, 52)	75% (73,79)	
Nurse has dedicated time for immunisations (108)					
Yes (67)	47% (36, 58)	70% (62, 77)	62% (56, 65)	78% (67, 81)	*p*=0.07
No (41)	22%(20,24)	70% (45, 74)	52% (46, 59)	74% (70, 77)	
Nurse professional experience as practice nurse					
Five or more years of experience (107)					
Yes (81)	36% (20,58)	70% (63, 77)	59% (46, 65)	75% (73,80)	*p*=0.50
No (26)	24% (24, 24)	68%(45, 74)	59% (58, 62)	65% (55, 78)	
Nurse attitudes					
Perceives parental apathy as a barrier to immunisation (109)					
Yes (56)	58% (58,58)	70% (63, 75)	62% (43, 63)	78% (73, 82)	*p*=0.005
No (53)	24% (20, 36)	68% (52, 77)	57% (49, 67)	72% (62, 75)	
Perceives parental fear as a barrier to immunisation (109)					
Yes (66)	36% (20, 58)	71% (57, 79)	58% (46, 62)	75% (71, 81)	*p*=0.008
No (43)	24% (24, 24)	67% (62 ,74)	62% (56, 76)	74% (55, 78)	
Nurse knowledge					
Comfortable with own level of knowledge (109)					
Yes (105)	30% (22, 47)	70% (61, 77)	58% (40, 63)	75% (71, 80)	*p*=0.0004
No (4)	(-)†	75% (5,82)	(-)†	70% (70, 70)	

* Adjusted for region, practice governance and socioeconomic deprivation of the registered population and age of children<2 years old

† No practices in this category

After adjustment for these same four variables more timely practice immunisation delivery was associated with; a lower ratio of nurses to children registered with the practice (*P*=0.007), nurse perception of increased parental apathy as a barrier (*P*=0.003) and her comfort in her knowledge about immunisation (*P*=0.049), (table 2).

In the multivariate analysis of nurse determinants of practice immunisation coverage, four factors were independently associated with higher practice immunisation coverage (table 3). The factors positively associated with higher coverage were lower ratio of nurse to children (*P*=0.04), nurse's increased perception of parental apathy (*P*=0.01) or fear (*P*=0.01) as a barrier to immunisation and the nurse's comfort in her immunisation knowledge (*P*<0.001). Three factors were independently associated with more timely practice immunisation delivery (table 3). These were lower ratio of nurses to children (*P*=0.03), nurse's increased perception of parental apathy (*P*=0.02) as a barrier to immunisation and the nurse's comfort in her immunisation knowledge (*P*=0.01).

In the multivariate models of coverage and timeliness the nurse variables accounted for an additional 12% of the variance in the coverage model and 11% of the variance in the timeliness model over and above that explained by region, practice governance, social deprivation and age of the children.

Table 2: Significant associations of practice nurse characteristics with immunisation timeliness at the practice

Variable (number of practices)	Median practice immunisation coverage (%) (25th, 75th centile)				
Region	***Auckland***		***Midland***		
Governance	Māori n=7	Non-Māori n=61	Māori n=14	Non-Māori n=36	*p* value[*]
Practice infrastructure relevant to delivery by nurses					
Ratio of practice nurses to children (115)					
1:1 to 1:74 (85)	37% (30, 46)	60% (47, 68)	44% (25, 57)	59% (47, 63)	*p*=0.007
1:75 to 1:1290 (30)	17% (17, 17)	52% (44, 66)	36% (31, 40)	61% (56, 64)	
Nurse attitudes					
Perceives parental apathy as a barrier to immunisation (109)					
Yes (56)	47% (47, 47)	60% (49, 68)	50% (36, 60)	60% (49, 63)	*p*=0.003
No (53)	23% (17, 32)	55% (40, 66)	42% (28, 54)	58% (36, 66)	
Nurse knowledge					
Comfortable with own level of knowledge (109)					
Yes (105)	28% (20, 40)	59% (44, 66)	44% (28, 57)	59% (47, 63)	*p*=0.05
No (4)	-[†]	76% (11, 78)	-[‡]	47% (47, 47)	
A cold is not a contraindication (107)					
Yes (83)	23% (17, 32)	58% (43, 66)	44% (28, 50)	60% (47, 64)	*p*=0.10
No (24)	47% (47, 47)	65% (49, 75)	62% (40, 67)	58% (35, 61)	
Completed a vaccination training course (109)					
Yes (102)	23% (17, 47)	58% (44, 66)	43% (25,52)	59% (47,63)	*p*=0.09
No (7)	32% (32, 32)	69% (58, 75)	64% (64, 64)	58% (58, 58)	

[*] Adjusted for region, practice governance and socioeconomic deprivation of the registered population and age of children<2 years old

[†] No practices in this category

Table 3: Multivariate analysis of practice nurse association with practice immunisation coverage and timeliness

	Association with coverage	Association with timeliness
R-squared for model	0.54	0.39
Number of practices in model	98	100
Region	<.0001	0.102
Social deprivation	<.0001	<.001
Median age of children registered at the practiced	<.0001	NS
Māori practice governance	0.039	0.056
Ratio of nurse to children in the practice	0.04	0.03
Nurse perceives parental apathy as a barrier to immunisation	0.01	0.02
Nurse perceives parental fear as a barrier to immunisation	0.01	-[*]
Nurse comfortable with own level of knowledge	<0.001	0.01

[*] This variable not included in multivariate model of practice immunisation timeliness

Study limitations

One nurse from each practice was interviewed and their responses may not reflect those of all the nurses in the practice. Immunisation coverage and timeliness was assessed as a 'one-off' measure and the precision would be lower for practices with fewer children under two years of age. Coverage and timeliness were assessed based on data obtained at the practice via the computerised query, thus they are dependent on the quality of data entry at the practice level. Data quality has been shown to vary depending on the practice management system used and the manner in which data is entered (Goodyear-Smith et al 2008).

Study strengths

The authors obtained a random sample of nurses with a high level of participation (93%). Data were collected and analysed maintaining the nurse data set as a distinct entity within the primary care variables. An independent, standardised and rigorous assessment of coverage and immunisation timeliness was used.

DISCUSSION

Practice nurses fulfil the principal role in immunisation delivery within primary care in NZ.

Nurse to child ratios

Nurses were responsible for immunisations in 95% of practices and are critical for successful program delivery. The nursing workforce is relatively mobile and NZ is affected by global nursing shortages (Kent et al 2005). Nurse to patient ratios have been associated with mortality rates in the hospital setting (Aiken et al 2003). It was found that practices with relatively more nurses, particularly experienced ones, were able to immunise their population more completely and in a timelier manner.

Nurse knowledge

Nurses were more likely to seek information from practice nurse colleagues than GPs suggesting a high level of expertise. Most nurses were confident in their knowledge despite significant gaps being shown. Lacking confidence was associated with lower practice coverage and more delay.

The wide variance in correct answers in this study is concerning. Knowledge gaps create the opportunity for conflicting advice that in turn leads to parental confusion delayed decision-making and delayed immunisations.

An often cited barrier to role expansion of the practice nurse includes inadequate education programs (Patterson et al 1999, Minto 2006, Ministry of Health 1998). A previous NZ study has shown that vaccinator training is associated with higher immunisation coverage (Petousis-Harris et al 2005). The finding that nurse comfort in immunisation knowledge is a predictor of better practice immunisation delivery, emphasises the importance of continued education.

Nurse Attitudes

It was found that nurse attitudes and increased perceptiveness around the parental barriers of apathy to, and fear of, immunisation were associated with higher uptake and timeliness. As attitudes are related to decision-making and depend on situational context (Prislin et al 2002), these perceptions may prompt the nurse to recommend immunisations more frequently and with greater empathy.

CONCLUSIONS

Nurses may be considered the immunisation leader in many practices, where their knowledge is sought after; they administer almost all childhood immunisations and invest a substantial amount of time with caregivers. Higher immunisation coverage is due, in part, to having an adequate number of nurses who are experienced, knowledgeable and can communicate well with caregivers. Improving nursing performance in general practice may contribute to further improvement in NZ immunisation coverage.

Investing in and retaining nursing staff needs to be considered in strategies to achieve and maintain high immunisation coverage. The nurse/child ratio could be explored as a useful practice management measure.

Further research could incorporate assessment of nurse understanding and communications on vaccine safety and efficacy.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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Original Scientific Paper

Comparison of general practitioner and practice nurse perceived barriers to immunisation uptake

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ABSTRACT

Objective

To understand immunisation issues confronting New Zealand general practitioners (GPs) and practice nurses (PNs), particularly comparing their perceptions of barriers to achieving high immunisation coverage in childhood and their knowledge of immunisation contraindications.

Methods

National computer-assisted telephone survey comparing responses of 150 randomly selected GPs and 150 randomly selected PNs. A triangulated multimethod approach was used by converging both quantitative and qualitative text data.

Results

Both GPs and PNs identified parental fear and misinformation about vaccine safety as the major barrier to immunisation uptake, but not access to services, lack of staff time or provider knowledge. Lack of funding was identified as a greater barrier by GPs than PNs. Many practitioners had poor knowledge on contraindications to vaccination but did not perceive the need for educational update. They desired user-friendly, evidence-based resources to communicate the relative benefits and risks of the scheduled vaccines to parents.

Conclusions

GPs and PNs identifying parental fear and misinformation as the greatest barriers to childhood vaccination is consistent with research on NZ mothers which found a pervasive underlying fear of vaccines and perceived side-effects. Difficulties in accessing services was perceived as a minor barrier to improving uptake. Practitioner misinformation on contraindications to vaccination may lead to missed vaccination opportunities.

Implications

Strategies that focus on primary health care provider support and education are more likely to gain high coverage than those that are primarily directed at overcoming access barriers.

Key words

Immunisation; family physician, primary health care; nurses

(NZFP 2005; 32:164–171)

Introduction

New Zealand (NZ) has a poor record with respect to childhood immunisation coverage, ranking 102nd out of the 193 listed countries for its primary infant series immunisation rates in 1998,[1] with coverage rates lower than those of many other westernised countries and of our Pacific neighbours.

Effective immunisation programmes require a high coverage level. For example, if measles is to be eliminated from a population, a coverage rate of at least 95% is required.[2] The Ministry of Health national target is a 95% coverage of children by the age of two years.[3] However, a 1992 national coverage survey found that less than 60% of children were fully immunised by aged two, with only 45% of Maori and 53% of Pacific children fully immunised.[4] A repeat coverage survey in 1996 in the northern region found minimal improvement, with 63% of children fully immunised at aged two.[5] Evidence indicates that national coverage has not improved significantly since then,[6] although some local district integrated primary health care initiatives have been able to obtain and maintain high immunisation coverage (>90%) for their populations, even without addressing the access issues with outreach services.[7]

In contrast to NZ, both Australia and the United States have substantially improved their immunisation coverage rate in recent years. This improvement has resulted from a number of concurrent approaches, in particular increased emphasis on the communication that vaccines are safe.[8,9]

The current NZ response to low coverage includes increasing the availability of outreach services and development of the National Immunisation Register to track children's immunisation status, which should become available in 2004–2005.

International literature shows that poor knowledge of immunisation by health professionals, rather than attitudes, is the single biggest factor in vaccine uptake.[10–13] One of the reasons for this is likely to be that well-educated health professionals can effectively communicate to parents the relative benefits and the risks of vaccination.[14] There is an active anti-immunisation lobby in NZ,[15] and evidence suggests that the activities of this group contribute to the eroding of public confidence in immunisation.[16] Recent research has indicated that many NZ parents have concerns about vaccine safety.[17] The numbers of parents choosing not to vaccinate their children because of fear may in itself be sufficient to prevent the 95% target uptake rate being achieved, even if all access barriers were addressed.[18]

The other key aspect to the importance of an informed health professional is the reduction in missed opportunities to vaccinate. The health professional missing opportunities that present in primary health care settings is frequently cited as one of the major reasons for failing to achieve high coverage.[19]

International literature shows that poor knowledge of immunisation by health professionals, rather than attitudes, is the single biggest factor in vaccine uptake

The immunisation schedule for NZ children is delivered within the primary health care setting. Over the past decade practising obstetrics has become less viable for general practice obstetricians, with their role taken over by midwives and specialist obstetricians. Most antenatal care now is usually provided outside of general practice, with less opportunity for general practitioners (GPs) and practice nurses (PNs) to discuss immunisation with parents both antenatally, and shortly after the birth of a child.

In most general practices, GPs and PNs work as a team. Providers of primary care have a unique opportunity to educate parents because parents see them as the most important source of information about immunisation.[20] The GP's primary role is to educate parents about immunisation issues, and to opportunistically encourage them to have their children vaccinated when they present for other health reasons. Doctors actively administer vaccines only in a minority of practices. A small number of sole GP practices do not employ PNs (7% of all practices)[21] and in these cases the doctor assumes all responsibility for immunisation administration. The PN's role generally involves not only parental education, but all aspects of immunisation delivery including ordering, safely storing (with documented evidence of maintenance of the cold chain) and administering vaccines to children, as well as maintaining a recall system for all children registered with the practice. In group practices with two or more doctors and nurses, at least one PN is likely to have attended one of the nationally standardised vaccinator training courses, which include two-yearly updates.

Most striking about these results is the relatively high percentages of GPs and PNs who wrongly considered specific conditions were contraindications

The aim of this study was to understand and compare the immunisation issues confronting NZ GPs and PNs using a national randomised computer-assisted telephone survey. The questions focused on general practice organisation issues; GP and PN perceptions of barriers to improving immunisation; their knowledge and educational needs regarding immunisation; preferred resources, and their own practices around immunisation.

Method

Both quantitative and qualitative text data were obtained through computer-assisted telephone surveys. These data were converged using a triangulation, multimethod approach to understand and compare immunisation issues confronting GPs and PNs.

The study was conducted between July 2002 and January 2003. The participants were GPs and PNs working in NZ general practices nation-wide. Interviewers were supplied with two separate lists of randomly-selected practices from a national general practice database and continued contacting practices in the order provided until 150 GPs and 150 PNs respectively had been recruited to the study. All practices carrying out childhood immunisations were considered eligible.

Inclusion criteria for GPs were any doctor working at the practice either part or full-time. Doctors working in locum tenure positions were excluded. In multi-practitioner settings the interviewers spoke to the first practitioner available. Similarly, for PNs the inclusion criterion was any immunising practice nurse working at the practice either part or full-time, with locum nurses excluded. In practices with more than one practice nurse, the nurse primarily responsible for administering vaccines was interviewed. Exclusion criteria were non-vaccinating practices included in the practice database (family planning clinics; some accident and medical centres; sports medicine practices) and practices without a practice nurse on the PN interviewer's randomised list.

Sample size calculation using EpiInfo 2000 indicated 150 GPs and PNs should be interviewed. This was

Table 1. Practitioner characteristics
N=150 for both groups

	GP N (%)	PN N (%)
Male	111 (74%)	2 (1.3%)
Worked full-time (=8/10)	123 (82%)	75 (50%)
Aged over 39 years	119 (79%)	117 (78%)
Practising 10 or more years	122 (81%)	66 (44%)

Table 2. Perceived barriers to improving immunisation
(GP: N = 150; PN: N = 150)
More than one barrier could be identified by respondents

Agreed barrier	GP n (%)	PN n (%)	*p*
Parental fear regarding immunisation	80 (53)	103 (68.7)	0.006
Lack of funding for providers	66 (44)	31 (20.6)	<0.001
Lack of time for providers to offer services	42 (28)	24 (16.0)	0.012
Poor Ministry of Health direction	41 (27)	4 (2.7)	<0.001
Patient difficulties accessing services	20 (13)	22 (14.7)	0.739
Lack of interest in the topic by providers	17 (11)	4 (2.7)	0.002
Lack of knowledge in health professionals	12 (8)	7 (4.7)	0.236

based on international literature that found an expected frequency of 53% of health professionals who would know that egg allergy is not a contraindication to MMR vaccination.[10] Given a population of approximately 3000 GPs and 3200 NZ PNs, a sample of 142 GPs and 143 PNs is needed, using standard error and 95% confidence interval, which is acceptably small (± 8% with a potential of further reduction for situations where expected frequency of incorrect responses is lower than 47%).

The design of the questionnaire was based on areas identified in the literature as barriers to immunisation. It also explored practitioners' educational needs and preferred sources for immunisation information. Interviewing was facilitated by a computer-assisted telephone survey tool that managed the sample and questions. The interview duration was approximately 20 minutes, with answers entered directly into the database for collation and analysis. Quantitative responses included yes/no answers; Likert scales, multi-choice options and demographic data including age, gender and nature, duration in, and location of, practice. Quantitative data analysis was conducted using EpiInfo 2000 where differences between GP and PN groups were sought. Cross tabulations were carried out to determine differences between age groups; years in practice; urban versus rural and responses to some of the key areas.

Qualitative data involved free-form answers to questions including other perceived barriers to immunisation, sources of information about immunisation and about adverse reactions. Free-form data response analysis used a general inductive approach with individual text responses initially analysed to identify subthemes. The data were then collated and analysed for emerging categories. These were combined into major themes through ongoing discussions and re-reading of the data by the first two authors until consensus about the main themes was achieved. The same codes were used for GP and PN responses where applicable. The data were independently double-coded as a consistency check with discrepancies resolved by adjudication.

The study had University of Auckland Human Ethics Committee approval.

Results

Details of the individual GP and the PN responses have been published elsewhere.[21,22] A total of 227 randomly selected eligible practices were contacted to reach a sample of 150 GPs (66% response rate). For PNs, a total of 168 randomly selected eligible practices were contacted to reach the 150 PN sample (89% response rate).

Practitioner demographics are outlined in Table 1. GP characteristics are similar to those of the Royal New Zealand College of General Practitioners' membership from 1996 and 2000 data in terms of age and years in practice.[23] Their average age was equal to the national GP population (44 years). The sample was matched for the main city centres; Auckland (33%), Wellington (7.3%) and Christchurch (9.3%), although it had a greater representation of rural participants than the national GP population (23% compared to 15%).[24] Although there was a larger representation of male over female GPs compared to the actual population (74% male compared to 64% nationally) there were no significant inter-gender differences in responses to several key questions. All but two of the PNs were female with the majority aged over 39 years. However 56% had been in practice less than ten years, indicating a relatively late onset to this vocation, with half working part-time.

Barriers to immunisation

Perceived barriers to improving immunisation are outlined in Table 2. Lack of access to immunisation services and of knowledge in health professionals were not identified as major barriers to immunisation coverage, and there was no significant difference between GPs and PNs in these responses. A majority of both GPs and PNs identified parental fear as a barrier, although this was significantly more of an issue for the PNs (Pearson's chi-square $(\chi^2)=7.412$; df=1; $p=0.006$). GPs were significantly more likely than PNs to identify as barriers lack of funding for providers ($\chi^2=18.66$; df=1; $p<0.001$.); lack of time for providers to offer services ($\chi^2=6.29$; df=1; $p=0.012$); poor Ministry of Health direction (Fisher's exact 2-tailed $p<0.001$) and lack of interest in the topic by providers (Fisher's exact 2-tailed p=0.002).

In the qualitative analysis, the strongest theme to emerge from the GPs was concerns about *'negative parental information'* they needed to overcome, especially the *'considerable amount of misinformation from midwives and anti-immunisation lobby groups'*. This theme was strongly echoed by the PNs with frequent comments such as *'Midwives are not giving immunisation a fair go, giving incomplete information to parents especially first-time parents'*.

A minority of GPs (13%) and PNs (15%) thought that patient difficulties accessing services was an important contributor to poor uptake. In their qualitative responses both GPs and PNs highlighted difficulties presented by transient patients (GP: *'Mobile population makes for difficulties in recall'*) and felt that patient apathy was a factor in some cases (PN: *'Just don't get around to it. Not important enough.'*).

Very few GPs (8%) or PNs (5%) perceived lack of knowledge in health professionals as a barrier to immunisation.

Table 3. Results for perceived contraindications to MMR and Pertussis vaccinations (GP: N=150; PN: N=150)

Correct answer rate	GP n (%)	PN n (%)	*p*
Perceived contraindication to MMR vaccination			
***Baby being treated for leukaemia**	84 (56)	50 (33)	<0.001
History of parental febrile fits	145 (97)	129 (86)	0.002
Baby has eczema	143 (95)	142 (94)	0.980
Baby reported to have had measles	137 (91)	123 (82)	0.017
Mother breastfeeding	133 (89)	140 (93)	0.158
Sibling has ADHD, autism or Aspergers	122 (81)	128 (85)	0.353
Baby with snuffly cold	119 (79)	122 (81)	0.663
Baby had a febrile convulsion at 11 months	110 (73)	119 (79)	0.222
Mother pregnant	99 (66)	114 (76)	0.056
Baby has spina bifida and hydrocephalus	72 (48)	84 (56)	0.166
Baby gets a rash eating eggs	54 (36)	65 (43)	0.194
Perceived contraindication to Pertussis vaccination			
***Baby has motor delay**	97 (65)	109 (73)	0.135
Sibling has eczema or asthma	150 (100)	148 (98)	0.498
Baby has eczema	146 (97)	141 (94)	0.256
History of parental febrile fits	145 (97)	141 (94)	0.256
Other sibling had fever following DTaP	141 (94)	146 (97)	0.256
Baby has snuffly nose / nasal discharge	127 (85)	116 (77)	0.105
Baby has spina bifida, no leg weakness	97 (65)	103 (69)	0.462
Baby had apnoea in first three weeks	75 (50)	92 (61)	0.048
Screaming for more than three hours after the previous immunisation	58 (39)	39 (26)	0.019
Baby had an HHE following previous immunisation	9 (6)	25 (16)	<0.001

*** Actual contraindications to immunisation**

ADHD:	Attention deficit hyperactivity disorder
HHE:	Hypotonic hypo-responsive episode
DTaP:	Diphtheria, tetanus and acellular pertussis vaccine

Practitioner knowledge and educational needs

The practitioners were asked what they considered to be contraindications to giving the MMR and pertussis vaccines (see Table 3). Most striking about these results is the relatively high percentages of GPs and PNs who wrongly considered specific conditions were contraindications. About 20% of both GPs and PNs incorrectly believed that MMR should not be given if a child has a snuffly nose, and the majority would withhold this vaccine if a child has evidence of egg allergy. Seven GPs (4.7%) and 12 PNs (8%) thought that six weeks was too young to start immunisation, and a further nine GPs (6%) and 20 PNs (13%) thought that was sometimes the case.

Significantly more PNs than GPs knew that apnoea in the first three weeks of life, screaming for more than three hours after the previous immunisation or a hypotonic hypo-responsive episode following a previous immunisation were not vaccine contraindications.

However, when asked about areas where they perceived a need for more education (see Table 4) only about a third of GPs felt that their knowledge on vaccines, their side-effects and information about the NZ schedule needed updating, and PNs were even more confident that they did not need education in these areas. Significantly fewer PNs (27% and 21% respectively) than GPs (38% and 33%) thought they needed more knowledge on vaccine side-effects or details around the immunisation schedule.

Both GPs and PNs were keen to get more information on current immunisation issues reported in the media (66% of both groups). They also wanted support with methods for obtaining informed consent, and answering parental concerns. This was significantly more important to GPs than PNs (56% compared with 39%, $\chi^2 = 8.35$, df1, p=0.004). GPs were also more interested in information on new vaccines than PNs.

In their qualitative responses, GPs were very vocal in their requests for resources to dispel parental fears (*'Would like leaflet for parents noting benefits of immunisation to counteract the misinformation'*; *'There should be active counteracting on anti-immunisation issues by the Ministry or other organisation'*) and PNs expressed similar opinions (*'anti immunisation in the media gets more coverage than the other side of the argument'*; *'Want accurate information to hand to parents disproving the myths'*).

Another area of need identified was international information (GP: *'Up-to-date opinions from the world regarding safety and risk disease prevalence patterns'*) including easy access to immunisation schedules from other countries, to facilitate immunisation updates for immigrant families (PN: *'Would like comparative schedule of immunisation for parents from abroad'*).

Table 4. Identified educational needs (GP: N = 150; PN: N = 150)

Topics on which practitioner wanted more information	GP n (%)	PN n (%)	*p*
Current issues reported in the media	99 (66)	99 (66)	1.0
New vaccines	102 (68)	73 (49)	<0.001
Support with methods for obtaining informed consent, and answering parental concerns	84 (56)	59 (39)	0.004
Knowledge of the vaccines	49 (33)	44 (29)	0.533
Knowledge around vaccine side-effects	57 (38)	41 (27)	0.049
Knowledge around NZ immunisation schedule, and rationale behind it	50 (33)	32 (21)	0.020
Knowledge of vaccine-preventable diseases	41 (27)	27 (18)	0.054
Knowledge around delivery techniques	28 (19)	24 (16)	0.542

Discussion and implications

There was considerable concordance between GPs and PNs regarding the key barriers to immunisation uptake. Both GPs and PNs indicate that the largest barrier to administering childhood vaccination is parental fear and that parental information is a problem, both in terms of misinformation and lack of information. This finding supports our recent research with NZ mothers which found a pervasive underlying fear of vaccines and perceived side effects.[17] Both parents who chose to vaccinate their children and those who actively object have concerns about immunisation safety.[25]

GPs were far more likely than PNs to identify lack of funding to health providers as a barrier. This is not surprising, given that GPs have to meet the costs of service delivery, including cold chain requirements and maintaining a recall system themselves. The latter includes software costs, staff time, mailing and telephone costs if the recall is posted. While scheduled immunisation for Tetanus, Diphtheria, Pertussis, Polio, Hib, Hepatitis B, Measles, Mumps and Rubella is free to NZ children, with the government paying for the vaccines and a small fee for each vaccine event, compliance costs may not be covered by the funding provided. A 1998 study found that given the frequency of recall reminders, there was a net cost to practices for childhood immunisation, after deducting the benefit rate.[29] A strong argument can be made for better funding the informed consent process, regardless of whether the ultimate outcome is parents agreeing to or declining the vaccination of their children.

Both GPs and PNs considered patient difficulties in accessing services as an unlikely or a minor barrier to improving immunisation. These findings are counter to the current NZ strategies which focus predominantly on structural barriers to accessing services,[30] rather than addressing misinformation and increasing public and professional confidence in the safety and necessity of the vaccination schedule.

Both GPs and PNs had a poor knowledge of contraindications to two primary vaccines – MMR and Pertussis (Table 3). However they did not rate their own lack of knowledge as an important factor in low immunisation coverage, and only a minority expressed a desire for further knowledge about the vaccines, their side-effects or delivery techniques. This is of considerable concern as overestimation of vaccine contraindications is very likely to lead to missing opportunities to vaccinate. With a fifth of GPs and PNs reporting that 'snuffly nose' is a contraindication to MMR vaccination, in this age group with a high incidence of this condition there is considerable scope for frequently missing opportunities to vaccinate. If GPs and PNs wrongly consider that children should not be immunised when in fact there are no contraindications, then they have an overly cautious approach in which opportunities to vaccinate are missed.

Even in the Rotorua district, where there is a relatively strong support of vaccinations, as demonstrated by their high coverage rate of 92% at two years of age,[7] research has shown that only 80% of GPs and PNs, and even fewer midwives, were confident that immunisations did not have unacceptable dangers.[26] For example, 21% of GPs, 41% of PNs and 45% of midwives were not sure whether MMR is implicated as a cause for autism or Crohn's disease, despite medical research reassuring health workers about the safety of this vaccine.[26–28] Our study also indicates that some GPs and PNs lack confidence in vaccine safety.

PNs being more knowledgeable about apnoea in infancy and hypotonic hypo-responsive episodes not being immunisation contraindications may reflect the vaccinator training undertaken by the PNs but not the GPs, but clearly further education for all practitioners is needed about conditions where it is safe to vaccinate.

Reluctance to start vaccinating infants at age six weeks is of concern, because small babies are most vulnerable to the serious sequelae of diseases, especially pertussis

Reluctance to start vaccinating infants at age six weeks is of concern, because small babies are most vulnerable to the serious sequelae of diseases, especially pertussis. If the primary health care team have a sound understanding of the safety issues around the vaccination schedule and basic immunology principles, they will be able to confidently encourage parents to vaccinate their children, and help address some of the anxieties and misinformation contributing to poor immunisation uptake.

A strength of this study is that it surveyed a randomly-selected representative sample of both NZ GPs and PNs and compared their attitudes towards immunisation and their knowledge regarding its safety. A limitation is that these are self-reported measures, which may not always reflect actual clinical practice.

Primary health care provider commitment to immunisation is a key aspect to improving coverage. PNs are the primary vaccinators of NZ children. The GPs and PNs surveyed indicated a strong desire for user-friendly, evidence-based resources to communicate to parents of young children the relative benefits and risks of the vaccines against preventable diseases provided in the schedule. Furthermore they are in need of further education strategies particularly around contraindications, to reduce the likelihood of missing opportunities within their practices to vaccinate. Strategies that focus on primary health care provider support and education are more likely to gain high coverage than those that are primarily directed at overcoming access barriers.

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Recruitment of practices in primary care research: the long and the short of it

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Goodyear-Smith F, York D, Petousis-Harris H, Turner N, Copp J, Kerse N and Grant C. Recruitment of practices in primary care research: the long and the short of it. *Family Practice* 2009; Pages 1–9 of 9.

Objective. To determine factors that facilitated or hindered recruitment of general practices into a large New Zealand primary care project that aimed to determine general practice characteristics of immunization coverage.

Methods. The project had a multi-level recruitment strategy requiring recruitment of randomly selected practices before randomly selecting GPs, practice nurses and caregivers of children enrolled at those practices. Detailed quantitative and qualitative recruitment data were recorded on an access database. Post-recruitment, recruiters underwent semi-structured interviews. Analysis was mixed method, with triangulation of descriptive statistics of the number of calls and time course to recruitment and general inductive thematic analysis of qualitative data.

Results. Identifying key decision makers and how individual practice processes work can save significant recruitment time. Factors identified as assisting practice recruitment included using a personal approach from doctor to doctor, getting buy-in from all practice staff, streamlining the research process to minimize disruption to the practice and flexibility to accommodate practices.

Conclusions. The task of recruiting should not be underestimated. Adequate time and resource need to be allocated from the onset. Long periods where practices have no added burdens such as audits, mass vaccination programmes or influenza season are unlikely, therefore there are always considerable challenges in recruiting practices for research. Remaining flexible to individual practice styles and influences and acknowledging the commitment of participants is important.

Keywords. Immunization, methods, primary health care, research design, vaccination.

Introduction

Research studies are essential for improving delivery of services in the primary care environment.[1] Use of practice-based research networks may facilitate recruitment in many studies.[2] However, when the research question requires optimal generalization of results, recruitment using random selection of all eligible participants may be preferable.

Often a major component of time spent on conducting research involves recruiting subjects to participate. Recruitment of participants is frequently the most difficult aspect of the research process[3] and many fail to recruit their planned number of participants.[1] There are ethical obligations, often conflicting, placed on the research team to maximize recruitment numbers for the benefit of the study and for the participants who agree to take part in the research.[4] A recent study indicated that most trials take longer to recruit than allowed for in their original timescale, with resulting additional funding requirements.[5]

The research team faces barriers that are frequently beyond their control. For example, health professionals and primary care practices who take part in research often have time constraints to consider and difficulties motivating their practice colleagues to participate.[6] A number of approaches are used by researchers to facilitate recruitment. Determining

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successful and unsuccessful strategies is beneficial to the research community and to society. Most studies on research recruitment for clinical trials have focused on enlisting individual patients rather than randomly selected practices.[7] Recruiting from research networks may be difficult enough. One US study had to send an invitation to 408 practices from three research networks in order to recruit 12 practices to participate in their study.[8] While randomization at the practice level may give a study great generalizablity, it may pose considerable challenges.

In New Zealand (NZ), most childhood immunizations occur within the primary health care/general practice setting and most are administered by practice nurses. A large primary care project was undertaken in the Auckland and Midland regions of NZ with the aim of determining general practice (family medicine) characteristics of immunization coverage and timeliness. This study had a multi-level recruitment strategy.

First, randomly selected practices were recruited, their immunization coverage and practice characteristics measured and the practice manager surveyed. Second, a randomly selected GP and randomly selected practice nurse were recruited for telephone interviews. Third, the caregivers of a random sample of children <2 years old who were enrolled at participating practices were invited for interview. The children's medical records then were reviewed for missed opportunities for immunization. Last, in a small number of practices, a practice nurse and the caregivers of children she was immunizing were recruited for a videotaped assessment of the immunization event.

Clearly, the key to this study was the initial successful recruitment of randomly selected practices. An assessment of the recruitment strategy and process was conducted. The aim of this study is to determine factors that facilitated or hindered recruitment of the general practices into the project.

Methods

Recruitment for the study took place between 2004 and 2005 at the Department of General Practice and Primary Health Care, The University of Auckland. The three GP researchers (FGS, NT and NK) in the study took primary responsibility for practice recruitment. The project manager (JC) prepared a detailed Access database of all general practices in the designated regions, including names and contact details of clinical personnel from a compiled master database. The research assistant (DY) liaised with recruited practices, extracted immunization data from their electronic medical records, surveyed the practice managers and interviewed the GP researcher/recruiters.

A sample size of 125 practices was calculated based on 80% power to show statistical significance at the two-sided 5% level for a practice characteristic/health professional knowledge measure/quality measure associated with higher immunization coverage if this characteristic/measure is present in 20% more of the practices with higher coverage. These calculations assumed that the characteristic or measures being examined have a frequency of between 10% and 70%.

The three recruiters were initially supplied with details of 75 practices randomly selected using a computerized number code. Where a recruiter personally knew the GPs at a particular practice, she/he could elect to invite that practice. The remainder of the randomly selected practices were equally allocated to the recruiters. Selected data describing these practices, including the designated recruiter, were placed on a shared network drive.

All telephone attempts to recruit the practice were recorded on the shared database. This included dates when contacts were attempted or successfully made, the person contacted, various notes such as identification of the key person to make the decision, concerns raised by the practice, other comments and the final outcome (recruited or declined). Data entry was facilitated by drop-down or automated options wherever possible (such as date and time of the call, role of person spoken with, outcome of each call), as well as text boxes for recording instructions (such as to ring Dr X at a particular time on a particular day) and comments (for example, that the practice was involved in another project but available to participate in 2 months). These data were utilized to analyse quantitative and qualitative aspects of the practice recruitment process, augmented by responses from the semi-structured interviews of the recruiters.

Once the practice had been recruited, the project manager initiated the informed consent and data collection processes. Once the 75 practices had been approached and either accepted or declined, further blocks of practices were randomized. Recruitment ceased when 125 practices had been enlisted into the study. Towards the end of the recruitment phase, a non-medical recruiter, the project manager, was also utilized in view of time constraints for the recruiters.

Following recruitment, a member of the research team (DY) conducted a semi-structured interview of the three GP recruiters and project manager regarding the barriers and enablers they perceived to successful recruitment (see Appendix 1). The data used in this study were records from the recruitment database, notes recorded during recruitment calls and responses from the interviews of the recruiting staff. Written records were produced from interviews with the recruiters. Analysis was mixed method, with triangulation of descriptive statistics of the number of calls and time course to recruitment and qualitative data analysis. For the latter, records from both the

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Access database text boxes and the recruiter interviews were read and reread and subjected to general inductive thematic analysis using a grounded theory approach.[9] Text was coded, reordered and summarized. Themes were coded by more than one reader to establish reliability.

Results

Response rates

From a total of 517 practices, 213 were randomly selected, of which 205 were eligible practices (provided immunizations to an enrolled paediatric population) and invited to participate (see Fig. 1) from which 124 practices were recruited (60% acceptance rate). Recruitment had ceased once 125 practices were enlisted but one subsequently dropped out.

The recruited practices were compared with those that declined with respect to their socio-demographic characteristics and funding types and were shown to be regionally representative. The practices were also compared with all primary care practices in NZ on a number of parameters and found to be representative, particularly with respect to their size and rural/urban mix.

Recruited practices had a larger proportion of registered patients from more socially deprived deciles than the national average ($\chi^2 = 0.346$, 1 d.f., $P < 0.001$). The NZ Social Deprivation Index combines a range of key socio-demographic factors to estimate an overall score of material and social deprivation for a particular area, on a scale of 1 (least deprived) to 10 (most deprived or experiencing considerable hardship). Social deprivation scores reflect the ability to achieve positive outcomes in spheres such as health, education and

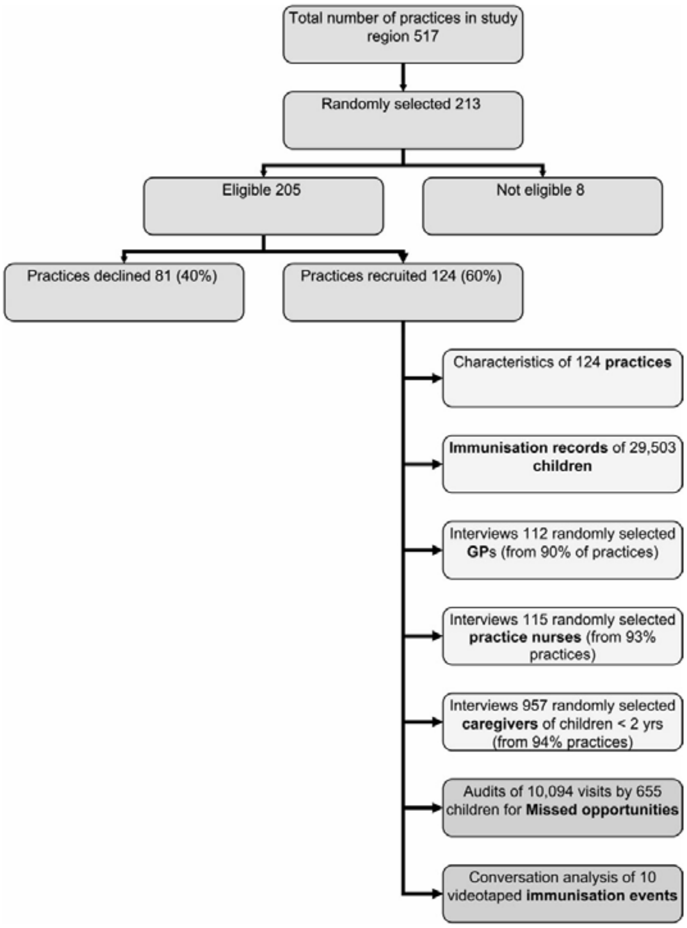
Total number of practices in study region 517
Randomly selected 213
Eligible 205
Not eligible 8
Practices declined 81 (40%)
Practices recruited 124 (60%)
Characteristics of 124 **practices**
Immunisation records of 29,503 **children**
Interviews 112 randomly selected **GPs** (from 90% of practices)
Interviews 115 randomly selected **practice nurses** (from 93% practices)
Interviews 957 randomly selected **caregivers** of children < 2 yrs (from 94% practices)
Audits of 10,094 visits by 655 children for **Missed opportunities**
Conversation analysis of 10 videotaped **immunisation events**

FIGURE 1 *Flowchart of practice recruitment and subsequent data sets*

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employment.[10] Given that Auckland and Midlands has a higher proportion of Māori and Pacific Island and areas of greater poverty than the national population, it would be expected that our practices reflected this.

The 124 recruited practices subsequently yielded data on 29 503 children, 112 randomly selected GPs, 115 randomly selected practice nurses, 957 randomly selected caregivers of children aged under 2 and 10 videotaped immunization events (Fig. 1).

Time and attempts needed to recruit practices

It took an average of 19 working days for Auckland and 25 working days for Midland from initial recruiter contact to practice consent. The simplest practices to recruit took only 1 day were small and run by the GP; while the practices that took the longest were generally larger organizations with salaried GPs and decisions requiring negotiation with management staff. Data collection completion from recruitment start date took between 12 and 358 working days for Auckland practices (average 92 days) and 5–292 working days for Midland (average 84 days) (Fig. 2).

The average number of calls to recruit a practice was three. Recruitment of a practice varied from a single phone call to 13 calls before the relevant staff member could be contacted and the recruitment decision determined. Following practice recruitment, up to 20 phone calls were made by other project staff (especially the project manager) to further inform practice staff and organize various components of the study. This did not include other forms of communication including faxes and emails.

Barriers to recruitment

Recruitment was hindered or delayed by several contemporaneous issues (see Fig. 3). Practices approached during April to June were busy with their annual influenza vaccination campaign and frequently asked for postponement of recruitment until this process was complete. A greater issue was that this project coincided with the staggered rollout of a mass immunization strategy to control a meningococcal epidemic (National Meningococcal B Immunisation Programme).[11] A vaccine to the NZ strain of group B *Neissseria meningitidis* had been developed in response to a nationwide epidemic. The national programme aimed to vaccinate 90% of children and young people aged under 20 years old with three vaccine doses between July 2004 and June 2006. Rollout for Auckland practices to deliver the vaccines to their pre-school populations started in November 2004 and in Midland in March 2005. This immunization campaign was a huge added time and resource burden on practices contributing to their decline or postponement to enter the study.

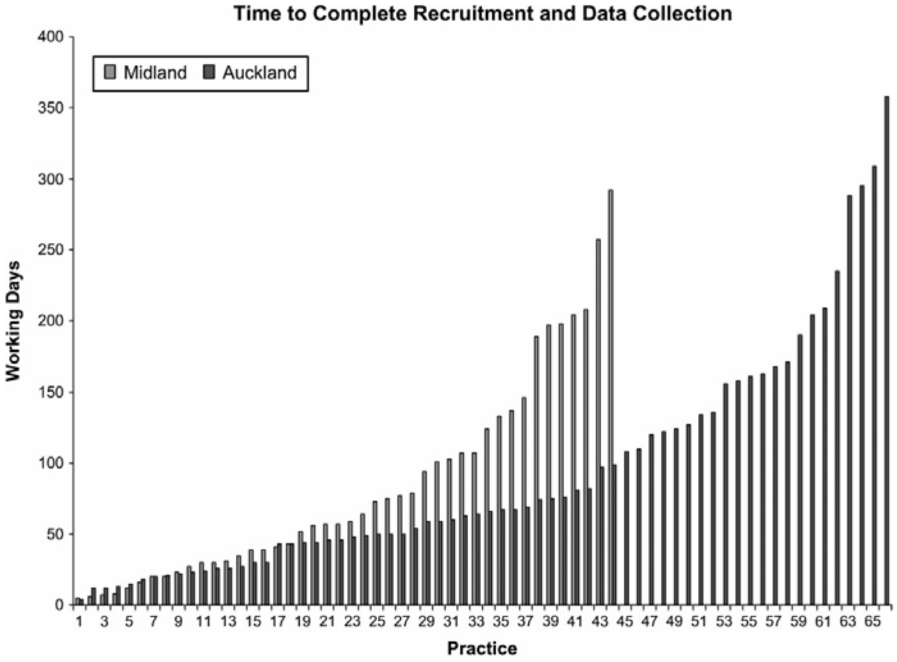

FIGURE 2 *Time taken for practice recruitment and data collection*

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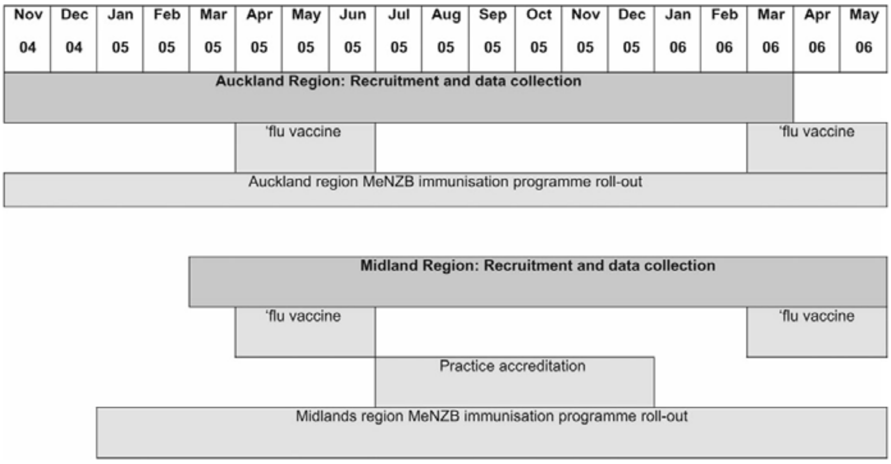

FIGURE 3 *Timeline of events concurrent with Auckland and Midland recruitment*

The third impediment was that many of the Midland practices were preparing for their Royal New Zealand College of General Practitioners' practice accreditation programme 'Cornerstone' from July 2005 to June 2006.[12] This is a major undertaking involving the entire general practice team in activities such as developing practice systems for clinical care and safety and legal issues. Many Midland practices postponed or declined because they were involved in the accreditation process.

Themes derived from recruiters' notes

Analysis of the comments entered in the text boxes by recruiters revealed five main themes. First, there was the need to clearly identify the practice staff members responsible for decision making at this level, who might be a GP owner, the practice manager (PM) or a group decision:

> Happy but needs to confer with others (GP, practice #84)
>
> Happy but needs to speak with practice manager (Head nurse, practice #90)

Second, there were concerns about the time involved in participation:

> Very busy, worried about time, give them flexibility to fit it in when they can' (GP, practice 42)

Third, practices would indicate that under their current circumstances, they could not consider involvement at present, but to contact them at a later date. Many of these were the events noted above

> Please ring after 31 July when MeNZB and flu finished (PM, practice #97).
>
> Practice very busy with Cornerstone. They are keen to be involved but can't do it for three months (GP, practice #32)

Others had different reasons for delays such as holiday periods or staff away:

> Prefer to wait until January. Will need re-contacting closer to Christmas (GP, practice #62)
>
> On holiday for two weeks—please schedule after then (GP practice #41)

to the more unusual

> Have had a burglary—had their server stolen—do not call for a week (PM, practice #91).

Another theme that emerged was the need to explain to practice staff the nature of the research process. There was a fear of 'not measuring up' with respect to their immunization coverage or knowledge and therefore a reluctance to engage. Some needed reassurance that the study was about checking their performance:

> Worried feels his records are a mess (GP/PM practice #401)

Sometimes it was even necessary to explain to staff eager to participate that the GP and nurse to be interviewed would be randomly selected not volunteers:

> Dr X wants to be the GP. I explained perhaps he wouldn't be (GP, practice #421)

The final prevalent theme from recruiter notes was the effect of practice variability. Different governance structures (such as solo practices, group practices and

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trusts) required different recruitment approaches to facilitate the practice to participate and to customize the process for them:

> Happy to be involved as long as organise via the receptionist (GP, practice #43)
>
> This is six businesses, six GPs with six dedicated practice nurses who share a PMS with all patients on it—all GPs must agree because cannot limit patient data we look at to one practice … need to decide whether this is one or six practices (GP, practice #359)

Initial contact with some practices was much more difficult than others

> Rang five times—number always engaged (recruiter FGS, practice #401)

Themes derived from recruiters' interviews

The second qualitative data set was the semi-structured interviews with the recruiters. These revealed similar barriers to recruitment:

getting to the decision maker:

> Identifying the right person who can promote the study to the rest of the staff, getting consensus (FGS)
>
> Not being able to access the decision-maker (JC)

overcoming resistance from fear of not measuring up:

> Reassurance that it is not an audit (FGS)

asking time-strapped practices to participate:

> The time commitment—asking a practice to do something else over and above their usual work load (FGS)

and timing issues:

> MeNZB, 'flu, accreditation, too busy (NT).

Recruiters had a number of suggestions on how to overcome some of the barriers.

These included offering incentives:

> Not just material, but educational as well (FGS)

recruitment using a personal approach GP to GP

> Doctor to doctor recruiting (JC)
>
> Personal connections with your colleagues (FGS)

getting buy-in from practice staff

> Make them feel included—not just passive participants (FGS)

and minimizing disruption to the practice from the research

> Streamlining process (NT)

GP to GP contact, at times, allowed the recruiter to get past the receptionist who might act as a gatekeeper to non-medical recruiters. In contacting the GP, it was important that the recruiter remained as the active communicator rather than leaving a message for the GP to return the call. This could mean continuing to ring at times that the receptionist indicated the GP might be available. Although the recruiter might have to ring a number of times, this avoided the situation of missing a return call from a GP or the GP failing to return the call.

The GP to GP approach sometimes had draw backs. A doctor might have difficulty saying no to a colleague. Rather than decline participation immediately, the decision would be deferred, requiring time-consuming follow-up from the research team with eventual refusal.

Time spent on recruitment was not commensurate with a successful recruitment. Frequently, the longer a practice took to recruit, the less likely it was to be a successful recruitment.

Practices easier to recruit were small; where the GP was also the owner and sometimes practice manager, where the GP was interested in the research and the practice was well organized:

> Small owner/operator easier to recruit. If GP is interested and is the decision maker as well. (NK)
>
> Had simple processes (FGS)

Conversely, large practices, particularly those run as trusts, were the most difficult to recruit. This is likely to be because of:

the complexity of their structures

> Multi-layered—identifying the right person, getting consensus (FGS)

an inability to identify the person with authority to make the decision

> A key person was non-existent (NT)

or governance issues

> Staff, time issues, organizational problems (NT)

Some practices did not want to participate but had difficulty declining, particularly if they knew the recruiter:

> Wanted to say no from the beginning and would drag it out (FGS)

All recruiters concurred that enlisting the practices was difficult, they suffered from 'recruiter fatigue' (NK) and the task was particularly demanding because of 'the complexity of the project' and its 'multi-levelled' nature (FGS).

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Discussion

The overall practice recruitment rate of 60% and the fact that these practices were generally nationally representative ensured success for the project.

Enablers to recruitment
Enablers to recruitment were both external and internal. External factors relate to how the practices respond to research, while internal factors relate to how the research is organized.

The recruiters reported that the greater the efficiency of administrative staff, the easier it was for a rapid decision to be reached. Many practices had clear processes to follow and decisions were made promptly.

Three key modifiable factors can be identified. First, the 'peer-to-peer' approach to recruitment was a useful strategy. Three recruiters for this research were themselves GPs. This approach is well established.[13–15] While a peer-to-peer approach can lead to bias and unrepresentative samples,[16] this approach worked effectively for a project of our nature, especially when there was a pre-existing relationship. Enlisting the assistance of a doctor in the recruitment process as the first point of contact reduces the possibility of being denied access to the practice.[15]

Direct phone calls have been found to be more effective than mailed invitations.[17] One study found that initial phone contact followed by a personal visit to the practice was a successful recruitment strategy.[18] Although previous studies have found urban practices easier to recruit than rural,[7] this was not our experience.

A review of factors influencing participation of community-based physicians in research previously has found that physician personal contact and friendship networks are powerful tools for recruitment[13] and that physician-to-physician recruiting can be a successful strategy.[7] However, 'cold calling' of doctors can sometimes yield good recruitment rates and may be a cost-effective strategy.[16] Reducing the burden on participating doctors, especially minimizing the time demands on themselves and their staff, and showing appreciation for their contribution, both in a material way (such as gifts) and psychologically (ameliorating their fears of individual evaluation), were also found to be helpful in recruitment.[13]

Identifying a 'local champion',[19] a key stakeholder who can introduce the researcher to the participants and assist with the 'buy-in' of other staff members, is helpful.[20,21]

A sense of partnership between researcher and participant can be a positive factor.[19] The researchers ensured that practices felt involved with every step of the study process were fully informed of its different stages and had timing to participate was flexible.

Barriers to recruitment
Recruitment at the primary care level may present the additional difficulty of a multi-layered nature to practice decision making. It was problematic recruiting a practice where consensus whether to take participate was needed from several GPs or practice staff before consent could be obtained. Secondary to this was difficulty in accessing the decision maker or the practice not having a clear process to make decisions about taking part in primary care research.

Declining practices sometimes initially consented because they did not wish to say no to a colleague. This resulted in unnecessary time spent pursuing these practices. Furthermore, use of doctors to recruit is a potentially expensive technique which may not be cost-effective for some studies.

To encourage participation, recruiters had to overcome perceptions that the research was too involved, time intensive or difficult to consider taking part in or that it was an audit measuring their performance. Staff pressures, including lack of time and being overworked, were common reasons to delay or decline taking part in the research. This required recruiters to 'sell' the research and present the benefits of enrolling in an activity over and above their already stretched daily activities.

The practices in both the Auckland and Midland region that took the longest to recruit and subsequently collect data from (358 and 292 days respectively) were both large practices that operated using a trust model. In both cases, a multi-layered level of consultation was required. Initially, it was unclear who were the key decision makers. Also in both cases, staff changes occurred while the research was conducted.

By keeping detailed records of the various contacts within the recruitment process and using a triangulation method to combine quantitative and qualitative data, this project was able to examine the recruitment process in some detail. Although an arduous process, recruiters were able to achieve an adequate recruitment rate using a random selection process of practices.

Limitations and strengths

This study has limitations with respect to its generalizability, given that it is as an observational study rather than a controlled trial comparing different recruitment strategies. Furthermore, there were occasional missing data in the recruitment database when recruiters worked off-site without access to the shared drive. However, entries were sufficient to indicate the number and the range of telephone contacts needed to enlist practices in the study.

While specific barriers to recruitment were identified that might be specific to the NZ environment [annual influenza vaccine programmes, rollout of

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a national immunization for Meningococcal B ImmunisationImmunization (MeNZB) or practice accreditation], in all primary care practices there will be numerous competing interests, and successful recruitment may require flexibility to accommodate the practices around these restraints.

A strength of this study into practice recruitment was the use of the detailed database recording the recruitment process with both quantitative and qualitative data. Triangulation of these data demonstrated not only the 'how and when' but also the 'why' decisions to consent or decline were made. Furthermore, responses from the recruiter interviews augmented the notes documented at the time of recruitment. At the interview, the recruiters were able to look back and assess the recruitment process as a whole and to expand on some of the issues that had emerged while they were recruiting.

Participant recruitment is key to any successful research project but may be the most difficult aspect to implement. Although recruitment was neither easy nor straightforward, partly our success can be attributed to the degree of flexibility offered to practices and to individuals. This included being available at times that suited them, postponing their involvement until a more convenient time and using a variety of communication modes including telephone, fax, email and face-to-face visits.

The task of recruiting into a study should not be underestimated and adequate time and resource needs to be allocated from the onset. Establishing who are the key decision makers and how individual practice processes work can save significant recruitment time. Long periods where practices have no added burdens such as audits, mass vaccination programmes or influenza season are unlikely and therefore there will always be considerable challenges in recruiting them to research. While our strategy proved successful, it may not work for all studies. Remaining flexible to individual practice styles and influences and acknowledging the commitment to participants are important.

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Appendix 1

Questions asked of recruiters in the interview at the conclusion of recruitment

What do you consider the main barriers to a practice being recruited?

Have you had any suggestions as to how you could overcome some of these barriers?

How would you compare the response to the research from a practice who was recruited compared with a practice that declined?

When recruiting, at what point did you strike difficulty? Any particular group?

Were there any differences in the time of day or day of the week that achieved a higher consent/decline rate?

Any geographical differences? Rural/Urban; Midland/Auckland?

Any difference in type of provider? (Maori/Pacific)

What were some of the common reasons practices delayed?

What were some of the common reasons practices declined?

Compared with other studies you have been asked to recruit for, how did this project differ?

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22. Grant CC, Petousis-Harris H, Turner N, Goodyear-Smith F, Kerse N, Jones R, et al. Primary care practice and health professional determinants of immunisation coverage. Papers 22: J Paediatr Child Health 2011 Aug;47(8):541-549.

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ORIGINAL ARTICLE

Primary care practice and health professional determinants of immunisation coverage

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Aim: To identify primary care factors associated with immunisation coverage.

Methods: A survey during 2005–2006 of a random sample of New Zealand primary care practices, with over-sampling of practices serving indigenous children. An immunisation audit was conducted for children registered at each practice. Practice characteristics and the knowledge and attitudes of doctors, nurses and caregivers were measured. Practice immunisation coverage was defined as the percentage of registered children from 6 weeks to 23 months old at each practice who were fully immunised for age. Associations of practice, doctor, nurse and caregiver factors with practice immunisation coverage were determined using multiple regression analyses.

Results: One hundred and twenty-four (61%) of 205 eligible practices were recruited. A median (25th–75th centile) of 71% (57–77%) of registered children at each practice was fully immunised. In multivariate analyses, immunisation coverage was higher at practices with no staff shortages (median practice coverage 76% *vs* 67%, $P = 0.004$) and where doctors were confident in their immunisation knowledge (72% *vs* 67%, $P = 0.005$). Coverage was lower if the children's parents had received information antenatally, which discouraged immunisation (67% *vs* 73%, $P = 0.008$). Coverage decreased as socio-economic deprivation of the registered population increased ($P < 0.001$) and as the children's age ($P = 0.001$) and registration age ($P = 0.02$) increased.

Conclusions: Higher immunisation coverage is achieved by practices that establish an early relationship with the family and that are adequately resourced with stable and confident staff. Immunisation promotion should begin antenatally.

Key words: health personnel; immunisation schedule; primary health care; vaccination/ut (utilisation).

What is already known on this topic

1. Immunisation coverage is mediocre in New Zealand.
2. Until now, the majority of the research that has sought to explain this mediocre coverage has concentrated on family and household factors.
3. As immunisations are delivered by general practices, variability in the characteristics of these practices or of the health professionals that work there might be an important determinant of how well a practice delivers immunisation.

What this study adds

1. There is wide variability in the immunisation coverage achieved by general practices in New Zealand.
2. Socio-economic factors have a pervasive effect on immunisation coverage that is not explained by other practice or practitioner characteristics.
3. Better immunisation coverage is achieved by practices that establish an early relationship with the family and that are adequately resourced with stable and confident staff who place a priority on the delivery of quality immunisation services.
4. As most decision-making about immunisation occurs prior to the child's birth, the antenatal period is an opportunity for immunisation promotion.

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Childhood immunisation is one of the most cost-effective preventive services.[1] Despite this, many countries do not achieve coverage sufficient to obtain the maximum population health benefits that immunisation can provide. New Zealand (NZ) is one such country. A 2005 national survey showed that only 77% of 2-year-old children had received all scheduled immunisations.[2] Large socio-economic and ethnic disparities exist with children from lower socio-economic status backgrounds and from NZ's indigenous (Māori) population having lower immunisation coverage.[3,4]

NZ's poor immunisation performance is a long-standing issue. Surveys in 1992 and 1996 showed that between 60 and 70% of 2-year-old children were fully immunised, with lower coverage rates reported for Māori children.[2,5,6] During these decades, research seeking to explain incomplete immunisation emphasised the characteristics of the child, family and household,[5–7] and some attention to the role of knowledge and attitudes of health-care professionals.[8] In contrast, there has been less investigation of the health system and professional contributions to immunisation completeness.

Identification and elimination of health system and professional barriers has been central to improvements in coverage in Australia and the USA in recent decades.[9–12]

NZ primary care system is a mixed model of central government funding with part patient co-payment for general practice services. Immunisation delivery for all the schedule vaccines is free. There is near universal enrolment (registration) for all children in primary care.

The aim of this study was to determine the primary care practice and health professional characteristics associated with higher immunisation coverage in NZ.

Methods

Study design and setting

We conducted a survey of primary care practices in the Auckland and Midland regions of NZ. Approximately 50% of NZ children aged 0–4 years reside in these regions.[13] Ethical approval was obtained from the Ministry of Health Regional Ethics Committee.

Study sample

We recruited a random sample of practices with stratification by region and, in view of the specific concerns with low immunisation coverage for indigenous children, an over-sampling of Māori governance practices (independent Māori health providers that target services primarily towards Māori and have a Māori management and governance structure).[14] There were 11 such practices in Auckland and 50 in Midland.

We aimed to enrol 125 practices. This number was sufficient to yield 80% power to show statistical significance at the 5% level for a practice or health professional characteristic associated with higher coverage if this characteristic was present in 20–25% more of the practices with higher coverage. These calculations assumed the characteristic being examined had a frequency between 10 and 70%.[15]

Data collection and measurements

Once informed consent was obtained from each recruited practice, we completed an audit of the immunisation records of all children from 6 weeks to 23 months old. Data that described immunisations received by each registered child and the child's age, age at registration and ethnicity were abstracted.

Practice characteristics, funding, co-payments, and immunisation recall and outreach used were described by interviewing a senior practice staff member. The socio-economic status of the registered practice population was measured using the NZ Index of Social Deprivation.[16] This measure uses census data that describe household income and ownership, household member employment and education, and household amenities and crowding.

We selected at random one doctor and one nurse per practice and invited them to complete a computer-assisted telephone interview. This interview explored their experience, immunisation knowledge and attitudes, perceived barriers to immunisation, sources of information and perceptions of practice teamwork. Health professional knowledge and attitudes about immunisation were measured using a questionnaire developed in the UK and adapted for NZ use.[17–19]

We identified a random sample of caregivers of children registered at each practice. Using a randomly ordered list of the registered children, the practice receptionist contacted the caregivers of these children, aiming for a sample of 10 children per practice. Following informed consent, caregiver access to and satisfaction with the practice was measured using the General Practice Assessment Survey administered via a computer-assisted telephone interview.[20,21] Their type of lead maternity provider and their immunisation knowledge and attitudes were also determined. Caregiver responses were aggregated by practice and were expressed as the median or predominant response per practice.

Data analysis

Immunisation coverage was defined using the third dose assumption. If the third in a series of vaccine doses was recorded as given, then it was assumed that the previous doses had also been given, whether or not they were recorded.[22] This assumption results in a small overestimate of coverage that is less than the underestimate, which occurs if only recorded doses are counted.[22]

Only data from children registered at each practice were included in the analysis. The proportion of children registered at each practice who had received their scheduled immunisations was described. The proportion immunised was transformed to facilitate analysis using the arcsin of the square root of the variable. This transformation made the variance constant across the distribution of coverage at each practice. We examined for interaction with either region or practice governance for any of the variables associated with coverage. Variables for which such interaction was present were not included in the statistical models.

A general linear model was created with the arcsin of the square root of the proportion immunised as the outcome variable. For the regression analyses, a base model was created,

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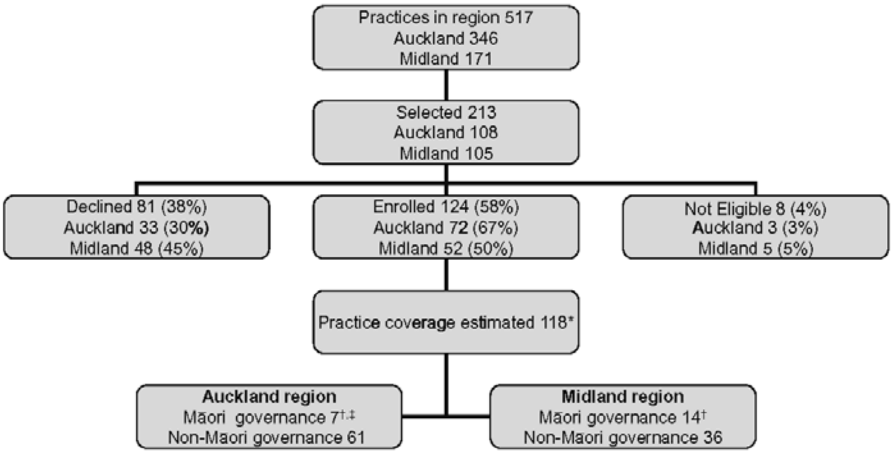

Fig. 1 Summary of practice recruitment and enrolment. *At one practice, none of the immunised children were registered. †Coverage for four Auckland and three Midland Māori governance practices was estimated as one practice. ‡One Auckland Māori governance practice was not eligible.

which included region, practice governance, socio-economic deprivation, and the age and age at registration of the children as explanatory variables. Explanatory variables that described practice characteristics, doctors, nurses and caregivers were added to this model. Multiple regression analyses were performed for each of these four areas and then a summary analysis that combined variables from all four areas.

Results

Practice recruitment (Fig. 1)

There were 517 practices in the study region. Two hundred thirteen (41%) were randomly selected, 108 in Auckland and 105 in Midland. A small number of practices were ineligible, mainly because they did not provide care for children. Practices were recruited between April 2005 and October 2006.

Of the 124 consenting practices, 112 were matched with NZ practices listed by the Ministry of Health. Of the 112 practices, 47 (42%) had access funding. A practice is eligible for access funding if 50% or more of registered patients are from high-deprivation communities and/or of Māori or Pacific ethnicities. Such funding increases the payments to the practice, which usually results in lower patient out-of-pocket fees.[23]

Thirty-eight per cent of selected practices declined to participate. In Auckland, 0% of the selected Māori governance and 36% of the non-Māori governance practices declined; in Midland, 48% of the Māori governance and 51% of the non-Māori governance practices declined. The proportion of selected practices that declined varied by region ($P = 0.006$) but not by Māori governance ($P = 0.21$).

The proportion of practices with access funding did not differ with recruitment (recruited 42% *vs* not recruited 43%, $P = 0.91$). Compared with all NZ primary care practices, a larger proportion of the recruited practices had access funding (42% *vs* 28%).

Immunisation data were available for 124 practices, practice characteristics for 122, doctor data for 111, nurse data for 114 and caregiver data for 109. In Auckland, four practices were under the governance of one Māori health provider, and in Midland, three practices were under the governance of another Māori health provider. The immunisation databases for these two providers were not separable by practice and thus were treated as a single practice. At one small practice, none of the immunised children were registered, and hence the data from this practice were not included in the analysis. Therefore, the denominator for coverage estimates was 118 practices.

Demographics of the children

The median number of children from 6 weeks to 23 months old registered at each practice was 116 (62–193). A median of 75% (64–88) of the children aged 6–23 months who had been seen was registered at each practice. The non-registered children included those who were casual patients, were visiting from elsewhere or were in the process of having their registration transferred from another practice.

Immunisation coverage (Fig. 2)

A median of 71% (57–77%) of registered children at each practice were completely immunised. There was a wide and negatively skewed distribution of practice immunisation coverage. Practice immunisation coverage varied by practice governance (Māori 56% *vs* non-Māori governance 73%, $P < 0.001$) and by region (Auckland 68% *vs* Midland 73%, $P = 0.02$).

Socio-economic deprivation, ethnicity and practice demographics (Table 1)

Practice immunisation coverage decreased as the proportion of the practice population in the most socio-economically deprived

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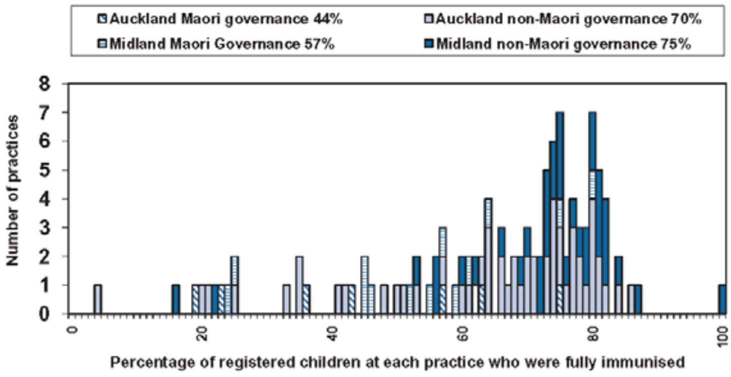

Fig. 2 Median percentage of children registered at each practice who were fully immunised.

Table 1 Practice immunisation coverage by socio-economic deprivation, practice funding and whether an urban or rural practice

Variable (number of practices)	Median practice immunisation coverage (25th–75th centile)				*P*-value†
Region	Auckland		Midland		
Governance	Māori *n* = 7	Non-Māori *n* = 61	Māori *n* = 14	Non-Māori *n* = 36	
Percentage of registered patients in most socio-economically deprived quintile‡ (118)					<0.001§
Less than 30% (86)	51 (44–58)	71 (63–78)	76 (46–80)	75 (71–80)	
30% or more (32)	36 (24–64)	63 (33–66)	56 (46–62)	77 (57–81)	
Access funding¶ (118)					0.28‡‡
No (72)	–††	71 (63–78)	80 (80–80)	75 (71–80)	
Yes (46)	44 (24–64)	65 (36–70)	56 (46–62)	75 (70–81)	
Urban or rural practice§§ (110)					0.20‡‡
Urban (90)	41 (22–66)	70 (63–77)	55 (46–62)	75 (73–81)	
Rural (20)	36 (36–36)	54 (52–65)	60 (56–65)	76 (57–80)	

†Analysis adjusted for region and governance. ‡Percentage in most socio-economically deprived quintiles included in the model as a continuous variable. §Based on the NZDep2001 Index of Deprivation, a small area-based measure that combines nine variables from the 2001 census, which reflects aspects of material and social deprivation.[24] ¶A practice is eligible for access funding if 50% of enrolled patients are from high-deprivation communities or are of Māori or Pacific ethnicities. ††No practices in this category. ‡‡Adjusted for region, practice governance and socio-economic deprivation of the registered population. §§As defined by a national rural ranking scale.[25]

quintile increased ($P < 0.001$). After adjustment for region, practice governance and socio-economic deprivation, there were no associations between the proportion of the registered practice population that was Māori ($P = 0.48$) or Pacific ($P = 0.15$) and the practice coverage (data not shown).

Characteristics of the children and the practice (Table 2)

Coverage decreased as median age of the registered children at the practice increased ($P < 0.001$) and as the median registration age increased ($P = 0.001$). The median percentage of registered children receiving each of the scheduled immunisations decreased with increasing age, with this association being most apparent for immunisations scheduled in the second year of life (6 weeks 93%, 3 months 91%, 5 months 87%, 15 months 71%).

Practice coverage was higher at practices where the practice management system MedTech (MedTech Limited, Auckland, NZ) was used rather than one of the three alternative computer software programmes ($P < 0.001$). Practice out-of-pocket patient fees charged for children <6 years old varied from $0 to $30 per appointment. After adjustment for social deprivation, region and governance, neither co-payments nor the proportion of patients that owed money was associated with coverage.

Nurse characteristics (Table 3)

Approximately half (48%) of the nurses worked full time. Ninety-five per cent of nurses reported they were the health

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Table 2 Practice immunisation coverage by characteristics of the registered children and of the practice

Variable (number of practices)	Median practice immunisation coverage (25th–75th centile)				*P*-value†
Region	Auckland		Midland		
Governance	Māori *n* = 7	Non-Māori *n* = 61	Māori *n* = 14	Non-Māori *n* = 36	
Characteristics of the registered children < 2 years old					
Median age of children (118)					<0.001
Less than 13 months (48)	54 (44–64)	70 (66–75)	60 (58–69)	78 (73–82)	
13 months or older (70)	36 (24–58)	66 (52–78)	49 (46–62)	75 (62–79)	
Median age of children at registration (118)					<0.001
Less than 3 months (72)	–‡	73 (63–77)	58 (46–62)	75 (73–80)	
3 months or older (46)	44 (24–64)	67 (42–71)	56 (47–62)	75 (62–79)	
Number of registered children (118)					0.59
Less than 150 (71)	40 (28–54)	70 (63–77)	57 (46–62)	75 (71–80)	
150 or more (47)	58 (24–75)	67 (42–75)	61 (47–76)	74 (67–82)	
Percentage of children seen at practice who were registered (118)					0.31
Less than 75% (56)	36 (20–44)	68 (53–75)	62 (56–65)	74 (56–81)	
75% or more (62)	61 (41–70)	70 (63–78)	47 (46–52)	76 (73–80)	
Characteristics of the practice					*P*-value§
MedTech is the patient management system used (117)					<0.001
Yes (89)	51 (36–64)	71 (65–77)	58 (47–65)	75 (73–81)	
No (28)	20 (20–20)	63 (45–76)	52 (36–60)	75 (56–79)	
Practice charges for appointments for registered children (117)					0.20
No (86)	44 (24–64)	67 (52–77)	56 (46–62)	74 (62–79)	
Yes (31)	–‡	75 (67–79)	80 (80–80)	80 (74–82)	
>15% of registered patients at the practice owed money (116)					0.27
Yes (43)	51 (24–64)	63 (52–73)	54 (46–62)	73 (65–77)	
No (73)	36 (36–36)	73 (65–78)	60 (52–63)	76 (70–82)	
Immunisation audited at least monthly (117)					0.25
Yes (32)	58 (37–75)	69 (52–73)	69 (62–76)	74 (70–80)	
No (85)	34 (22–54)	73 (65–78)	54 (46–61)	76 (71–82)	
Practice has specific immunisation clinics or appointments (117)					0.27
Yes (40)	44 (36–64)	70 (62–75)	52 (47–76)	81 (67–82)	
No (77)	41 (22–66)	70 (61–77)	58 (46–62)	75 (73–79)	
Practice has staff shortages (117)					0.06
Yes (76)	51 (36–64)	69 (52–75)	56 (46–62)	73 (67–80)	
No (41)	20 (20–20)	70 (64–79)	76 (46–80)	79 (75–81)	

†Adjusted for region, practice governance and socio-economic deprivation of the registered population. ‡No practices in this category. §Adjusted for region, practice governance and socio-economic deprivation of the registered population, age and registration age of children <2 years old.

professionals usually responsible for administering vaccines. Most (94%) had completed a vaccinator training course and virtually all (98%) were confident about their ability to deliver childhood immunisations.

Practice coverage was higher if the nurse had dedicated time for immunisation follow up ($P = 0.01$) and if the nurse perceived parental fear ($P = 0.02$) or apathy ($P = 0.01$) as a barrier to immunisation.

Doctor characteristics (Table 4)

Eighty per cent of the 112 doctors worked full-time, of whom 61% had more than 10 years experience.

Parental apathy was perceived as a barrier to immunisation by 70% of doctors, parental fear or ambivalence by more than half and access difficulties by 19%. Doctor perception of access difficulties as a barrier to immunisation was associated with higher coverage ($P = 0.04$).

The majority (84%) of doctors were confident in their immunisation knowledge, and such confidence was associated with higher coverage ($P = 0.002$). Knowledge regarding contraindications to immunisations was variable and incomplete. Correct knowledge was associated with higher coverage.

Caregiver characteristics

A median of eight caregivers per practice (total = 957) participated in the survey. The majority (67%) made their decision regarding immunisation while pregnant. Only 62% of caregivers reported having received immunisation information

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Table 3 Practice immunisation coverage by practice nurse characteristics

Variable (number of practices)	Median practice immunisation coverage (25th–75th centile)				*P*-value†
Region	Auckland		Midland		
Governance	Māori *n* = 7	Non-Māori *n* = 61	Māori *n* = 14	Non-Māori *n* = 36	
Nurse workload and experience					
Ratio of practice nurses to children (115)					0.31
1:75 to 1:290 (30)	24 (24–24)	67 (52–71)	49 (47–52)	75 (73–79)	
1:1 to 1:74 (85)	51 (36–64)	73 (64–77)	58 (46–63)	75 (71–82)	
Nurse has dedicated time for immunisation follow up (108)					0.01
Yes (67)	47 (36–58)	70 (62–77)	62 (56–65)	78 (67–81)	
No (41)	22 (20–24)	70 (45–74)	52 (46–59)	74 (70–77)	
5 years or more of experience (107)					0.15
Yes (81)	36 (20–58)	70 (63–77)	59 (46–65)	75 (73–80)	
No (26)	24 (24–24)	68 (45–74)	59 (58–62)	65 (55–78)	
Nurse attitudes					
Perceives parental apathy as barrier to immunisation (109)					0.02
Yes (56)	58 (58–58)	70 (63–75)	62 (43–63)	78 (73–82)	
No (53)	24 (20–36)	68 (52–77)	57 (49–67)	72 (62–75)	
Perceives parental fear as a barrier to immunisation (109)					0.01
Yes (66)	36 (20–58)	71 (57–79)	58 (46–62)	75 (71–81)	
No (43)	24 (24–24)	67 (62–74)	62 (56–76)	74 (55–78)	
Perceives parental ambivalence as a barrier to immunisation (109)					0.54
Yes (54)	58 (58–58)	71 (57–78)	57 (52–62)	75 (67–80)	
No (55)	24 (20–36)	69 (62–75)	61 (46–76)	75 (74–82)	
Nurse contraindication knowledge					
Knowing that a 'cold' is not a contradiction§ (107)					0.07
Yes (83)	24 (20–36)	70 (62–75)	58 (36–63)	75 (70–80)	
No (24)	58 (58–58)	70 (52–78)	62 (52–76)	75 (65–78)	
Knowing that a previous HHE is not a contradiction¶ (79)					0.09
Yes (41)	24 (24–24)	73 (64–77)	62 (62–62)	73 (57–80)	
No (38)	36 (20–58)	68 (52–75)	59 (52–75)	74 (70–78)	
Knowing that a rash after eating eggs is not a contradiction§ (93)					0.84
Yes (60)	–‡	71 (62–77)	71 (62–80)	75 (73–82)	
No (33)	36 (20–58)	67 (52–71)	56 (38–67)	75 (71–80)	

†Adjusted for region, practice governance and socio-economic deprivation of the registered population, age and registration age of children <2 years old. ‡No practices in this category. §With respect to MMR vaccine. ¶With respect to acellular pertussis vaccine. HHE, hypotonic hyporesponsive episode; MMR, measles mumps rubella.

antenatally. Twenty-nine per cent of caregivers received information that discouraged them from immunising their child. Receipt of such information was associated with lower coverage (67% *vs* 73% $P = 0.03$).

Combined analysis (Table 5)

The multiple regression model of demographic, practice, nurse, doctor and caregiver associations with practice immunisation included 76 practices and explained 80% of the variance in coverage between these practices. Coverage varied with region ($P = 0.002$) and practice governance ($P < 0.001$). Coverage decreased as socio-economic deprivation of the registered practice population increased ($P < 0.001$), as the average age of the children increased ($P < 0.001$) and as the registration age of the children increased ($P < 0.001$). Immunisation coverage was higher at practices that experienced no staff shortages (median practice coverage 76% *vs* 67%, $P = 0.004$), where the doctor was confident in his/her immunisation knowledge (72% *vs* 67%, $P = 0.005$) and where the nurse had dedicated time for immunisation follow up ($P = 0.05$). Coverage was lower at practices where caregivers had received discouraging information about immunisation antenatally (67% *vs* 73%, $P = 0.008$).

Discussion

Our survey demonstrated mediocrity and wide variability between practices in immunisation coverage. Socio-economic deprivation had a strong negative effect on coverage. Coverage was higher in practices that were able to formalise a relationship

Table 4 Practice immunisation coverage by doctor (family physician) characteristics

Variable (number of practices)	Median practice immunisation coverage (25th–75th centile)				*P*-value†
Region	Auckland		Midland		
Governance	Māori *n* = 7	Non-Māori *n* = 61	Māori *n* = 14	Non-Māori *n* = 36	
Doctor perceptions of barriers to immunisation					
Perceives parental access difficulties as a barrier (106)					0.04
Yes (19)	58 (58–58)	70 (63–75)	69 (44–78)	74 (22–75)	
No (87)	24 (20–36)	70 (61–77)	56 (46–59)	77 (70–82)	
Perceives parental apathy as a barrier (106)					0.25
Yes (70)	36 (29–58)	67 (52–75)	55 (36–63)	75 (71–81)	
No (36)	24 (24–24)	74 (68–80)	59 (56–62)	75 (61–79)	
Perceives parental fear as a barrier (106)					0.22
Yes (58)	36 (36–36)	71 (52–77)	54 (46–59)	76 (73–82)	
No (48)	24 (20–58)	70 (65–77)	62 (46–76)	72 (57–80)	
Perceives parental ambivalence as a barrier (106)					0.59
Yes (50)	47 (36–58)	73 (62–77)	54 (36–63)	77 (71–82)	
No (56)	22 (20–24)	69 (63–75)	59 (58–62)	74 (61–80)	
Doctor immunisation practice and knowledge					
Confident in knowledge about immunisation (106)					0.002
Yes (84)	30 (22–47)	70 (63–77)	62 (56–65)	76 (70–81)	
No (22)	–‡	68 (46–78)	39 (25–56)	73 (70–81)	
Doctor contraindication knowledge					
Knowing that being treated for leukemia is a reason to delay immunisations§¶ (73)					0.01
Yes (46)	–‡	72 (67–75)	62 (59–65)	75 (73–81)	
No (27)	58 (58–58)	63 (52–74)	39 (26–52)	71 (56–78)	
Knowing that fever is not a contradiction§ (106)					0.04
Yes (73)	30 (22–47)	71 (65–78)	58 (46–65)	78 (74–83)	
No (33)	–‡	64 (42–75)	56 (46–62)	73 (61–80)	
Knowing that a rash after eating eggs is not a contradiction¶ (81)					<0.001
Yes (47)	30 (24–36)	74 (69–79)	60 (26–65)	75 (73–80)	
No (34)	58 (58–58)	70 (63–75)	60 (56–69)	76 (57–81)	

†Adjusted for region, practice governance and socio-economic deprivation of the registered population, age and registration age of children <2 years old. ‡No practices in this category. §Rather than as not a contraindication or a reason never to immunise the child. ¶With respect to MMR vaccine. MMR, measles mumps rubella.

with children at a younger age. Practices wherein the staff were confident about immunisation and wherein immunisation was an organisational priority achieved higher coverage. Immunisation coverage suffered when practices experienced staff shortages.

Socio-economic deprivation, rather than ethnicity, was the dominant determinant of practice coverage. Much of the apparent association between ethnicity and immunisation coverage was explained by the confounding effect of social deprivation. Our analysis confirms that factors associated with socio-economic deprivation are powerful barriers to immunisation.[11] Such barriers can be overcome but require additional resources to provide education, to identify the children who need to be immunised, to use opportunistic and outreach immunisation, and to have ready access to an accurate and complete immunisation register.[26]

Coverage varied by both region and practice governance. The regional differences were not explained by differences in socio-economic deprivation nor by the more rural demographics of the Midland region.[16,27] Although there is a national immunisation schedule, the resources devoted to immunisation delivery are likely to vary by District Health Board and hence region, both in amount and areas of focus for resourcing. Such variance in funding may account for these regional differences.

Coverage was lower in Māori governance practices. A nationally representative survey of Māori providers showed they serve a young patient population, which is disproportionately from more deprived areas.[14] Māori governance practices have community representation as a feature of their governance structure and employ more community health workers. A larger proportion of patients are seen by nurses rather than by doctors at these practices. These aspects of structure provide a framework within which immunisation delivery by these practices can improve.[14]

That the formation of an early relationship with the primary care practice is a critical aspect of immunisation delivery is

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Table 5 Combined analysis of practice, child, health professional and caregiver associations with practice immunisation coverage

Variable	Direction of effect on coverage	Multivariate *P*-value
Demographics		
Region		0.002
Auckland	Higher in Midland	
Midland		
Governance		<0.001
Māori governance	Higher in non-Māori governance practices	
Non-Māori governance		
Socio-economic deprivation	Decreased with increased socio-economic deprivation	<0.001
Age of registered children	Decreased with increasing age	<0.001
Practice		
Age of children at registration	Decreased with increasing age at registration	<0.001
Staff shortages	Higher in practices that did not have staff shortages	0.004
Nurse		
Nurse has dedicated time for immunisation follow up	Higher at practices where the nurse has dedicated time	0.05
Doctor		
Doctor confident in knowledge about immunisation	Higher at practices where the doctor is confident in his/her knowledge	0.005
Caregiver		
Received discouraging information about immunisation antenatally	Lower at practices where the caregivers received discouraging information	0.008

Other variables in the model for which associations with coverage were not significant: patient management system used ($P = 0.14$), nurse comfortable with own immunisation knowledge ($P = 0.98$) and nurse perception of parental fear ($P = 0.17$) or apathy ($P = 0.20$) as barrier to immunisation.

self-explanatory. Delay in the receipt of the first dose in the primary series is one of the strongest predictors of subsequent incomplete immunisation.[28–30] NZ needs more effective facilitation of early registration of newborns with the primary care practice, in particular improving the process of transition from perinatal care providers.

Achieving this important early relationship in the NZ context is surprisingly complex. Since the 1990s, primary health care during pregnancy and post-partum has been delivered predominantly by midwives.[31] Post-natally, the midwife refers the newborn infant to two different well care providers: the primary care practice for that child's immunisations and another provider for most other components of well child care.[32] Earlier registration will require better communication and coordination between these various providers. NZ needs to consider the better integration of general practice with well child care and the reintroduction of general practitioners into antenatal care.[33]

As caregiver decision-making regarding immunisation occurs predominantly before the child is born, this is the most appropriate time to provide education about immunisation. Parental immunisation knowledge improves when such antepartum education is provided.[34] Seizing this 'teachable moment' to support informed decision-making regarding immunisation would also remove the opportunity that the anti-immunisation lobby currently appears to have for their message to be heard first.[35,36]

Health literacy across both the health professionals and the public is likely to have an effect on immunisation coverage, and further studies may be warranted to delineate this factor further.

This study had several limitations. The response rate was 61%. This project coincided with a national immunisation strategy to control a meningococcal epidemic and a large primary care practice accreditation process in the Midland region. Both affected practices' ability to engage with this project. Practices that struggled to cope with these competing issues may have been less likely to participate in this study. Despite this, we recruited a sample of urban and rural practices that served a wide socio-economic and ethnic spectrum, and had immunisation coverage that spanned a range from 4% to 100%.

We were limited to interviewing one doctor and one nurse from each practice. Their responses may not have been representative of all practice staff. Seeking to interview multiple doctors and nurses would have resulted in an unacceptably high respondent burden. The number of caregivers enrolled from each practice was small. With privacy considerations preventing us access to patient lists and hence reliance upon practice staff to make the initial contact, we had to accept a smaller sample than might have been desirable.

This study demonstrates that there are modifiable primary care determinants of immunisation coverage. These include early establishment of a relationship between the health-care provider and the child's caregivers, having a practice that is adequately resourced with stable staffing and confident health providers who place a priority on the delivery of quality immunisation services. These are the key determinants of a practice's ability to immunise the children for whom it is the identified health-care provider. Individual practices with such characteristics can obtain high immunisation coverage, even in areas of

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high socio-economic deprivation and in an environment where there is overall mediocre coverage.

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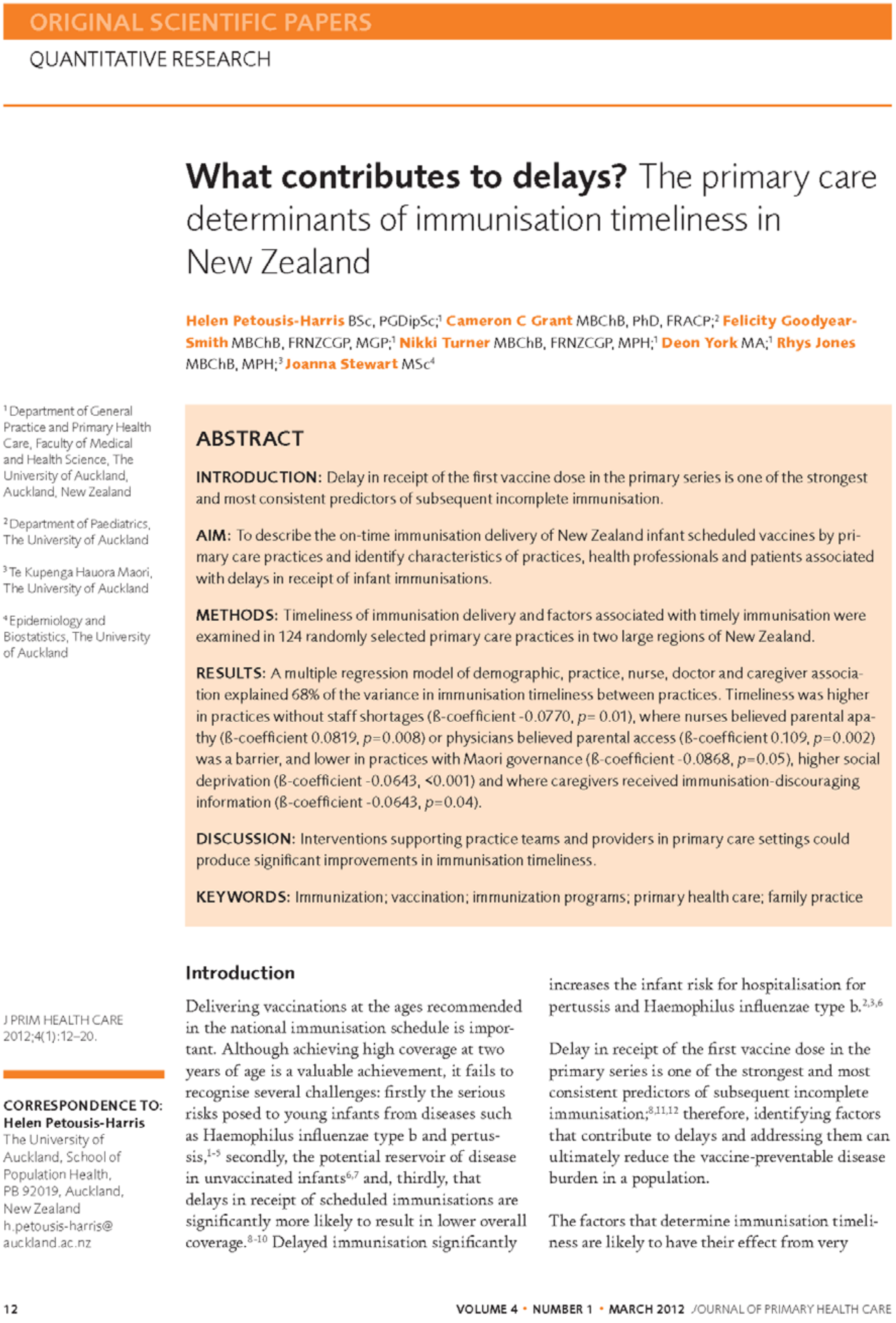

What contributes to delays? The primary care determinants of immunisation timeliness in New Zealand

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ABSTRACT

INTRODUCTION: Delay in receipt of the first vaccine dose in the primary series is one of the strongest and most consistent predictors of subsequent incomplete immunisation.

AIM: To describe the on-time immunisation delivery of New Zealand infant scheduled vaccines by primary care practices and identify characteristics of practices, health professionals and patients associated with delays in receipt of infant immunisations.

METHODS: Timeliness of immunisation delivery and factors associated with timely immunisation were examined in 124 randomly selected primary care practices in two large regions of New Zealand.

RESULTS: A multiple regression model of demographic, practice, nurse, doctor and caregiver association explained 68% of the variance in immunisation timeliness between practices. Timeliness was higher in practices without staff shortages (ß-coefficient -0.0770, $p= 0.01$), where nurses believed parental apathy (ß-coefficient 0.0819, $p=0.008$) or physicians believed parental access (ß-coefficient 0.109, $p=0.002$) was a barrier, and lower in practices with Maori governance (ß-coefficient -0.0868, $p=0.05$), higher social deprivation (ß-coefficient -0.0643, <0.001) and where caregivers received immunisation-discouraging information (ß-coefficient -0.0643, $p=0.04$).

DISCUSSION: Interventions supporting practice teams and providers in primary care settings could produce significant improvements in immunisation timeliness.

KEYWORDS: Immunization; vaccination; immunization programs; primary health care; family practice

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Introduction

Delivering vaccinations at the ages recommended in the national immunisation schedule is important. Although achieving high coverage at two years of age is a valuable achievement, it fails to recognise several challenges: firstly the serious risks posed to young infants from diseases such as Haemophilus influenzae type b and pertussis,[1-5] secondly, the potential reservoir of disease in unvaccinated infants[6,7] and, thirdly, that delays in receipt of scheduled immunisations are significantly more likely to result in lower overall coverage.[8-10] Delayed immunisation significantly increases the infant risk for hospitalisation for pertussis and Haemophilus influenzae type b.[2,3,6]

Delay in receipt of the first vaccine dose in the primary series is one of the strongest and most consistent predictors of subsequent incomplete immunisation;[8,11,12] therefore, identifying factors that contribute to delays and addressing them can ultimately reduce the vaccine-preventable disease burden in a population.

The factors that determine immunisation timeliness are likely to have their effect from very early in the child's life, or even before the child is born. There is a range of factors that contribute to vaccine uptake, including the knowledge and attitudes of caregivers,[13-16] attitudes of health professionals[17,18] and aspects of health care systems such as cost, recall and reminders, and cost to provider.[19] Little is known about the impact of these factors on immunisation in New Zealand, a country that has traditionally had a significant problem with low immunisation coverage[20] and relatively high rates of vaccine-preventable disease.[21]

Aim

The aims of our study were to describe the on-time immunisation delivery of the New Zealand infant scheduled vaccines by primary care practices and to identify the characteristics of the practices, the health professionals and the patients that are associated with delays in receipt of infant immunisations.

Methods

This study was part of a comprehensive project exploring the contributions of different health system factors to immunisation coverage and timeliness in New Zealand. These methods have been previously reported.[22-25]

The Ministry of Health definition of on-time immunisation was used, being receipt of the six-week immunisation within four weeks of due date and within six weeks of due date for the three-month, five-month and 15-month immunisations.[26] A delayed immunisation is, therefore, one that is delivered beyond this time window.

WHAT GAP THIS FILLS

What we already know: Many factors are known to affect immunisation rates—socioeconomic factors, health care system factors and family and child factors. The relative contribution of various factors is not well established and less is known about the factors that affect timeliness of delivery.

What this study adds: The key factors affecting timeliness of delivery of the childhood immunisation schedule in the primary care setting are demonstrated: the dominant environmental factors are social deprivation in the enrolled population, ethnicity and early enrolment of infants; significant practice systems factors are staffing stability and type of practice management system used. Provider issues are around confidence and engagement; and the major parental issue is having contact with discouraging material in the antenatal arena.

Study design and setting

A survey of primary care practices was conducted from 2005 to 2007 in the Auckland and Midland regions in New Zealand which care for approximately 50% of all New Zealand children aged 0–4 years. Ethical approval was obtained from the Ministry of Health Auckland Regional Ethics Committee.

Study sample

A random sample of 124 practices was recruited with stratification by region. As immunisation coverage is lower among Maori[27] there was oversampling of practices with Maori governance (practices that provide services primarily for Maori and that have a Maori management structure). The characteristics of the sample practices are described in Figure 1.

Figure 1. Summary of study sample

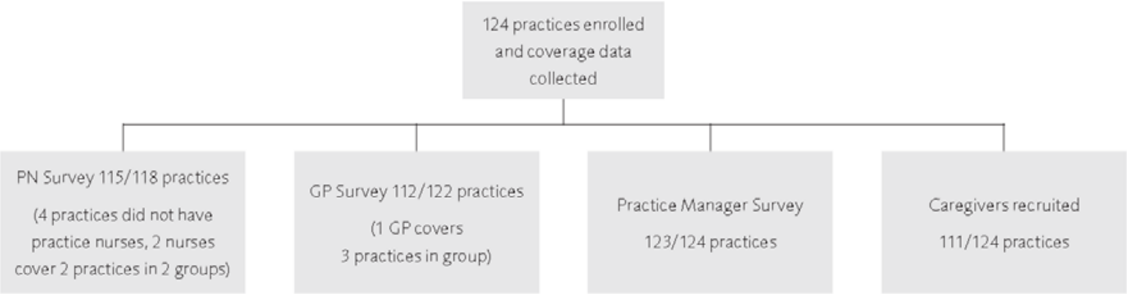

124 practices enrolled and coverage data collected
PN Survey 115/118 practices
(4 practices did not have practice nurses, 2 nurses cover 2 practices in 2 groups)
GP Survey 112/122 practices
(1 GP covers 3 practices in group)
Practice Manager Survey
123/124 practices
Caregivers recruited
111/124 practices

Table 1. New Zealand infant immunisation schedule at time of study

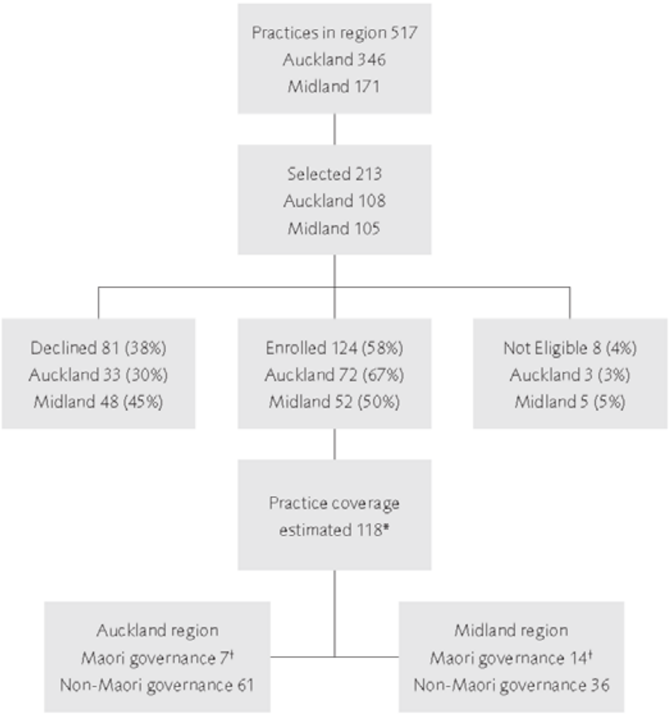
DTaP-IPV	Hib-HepB	HepB	DTaP/Hib	MMR
6 weeks	6 weeks			
3 months	3 months			
5 months		5 months		
			15 months	15 months

Data collection and measurements

An audit was conducted of the recruited practice immunisation records of all children six weeks to 23 months. The immunisation schedule for children under two years of age at the time of this study is shown in Table 1.

Records describing immunisations received by each registered child and their age at registration were extracted from the Practice Management System (PMS). Interviews with practice managers or senior staff collected data about the characteristics of the practice, including funding, co-payments and immunisation recall and outreach methods used. Socioeconomic status was measured using the New Zealand Index of Social Deprivation.[28]

Figure 2. Practice recruitment



* At one practice none of the immunised children were registered or enrolled

† Coverage for four Auckland and three Midland Maori governance practices were estimated as one practice.

One randomly selected general practitioner and one nurse per practice were invited to complete a computer-assisted telephone interview (CATI) exploring their experiences, knowledge, attitudes, perceived barriers to immunisation, sources of information and perceptions of practice teamwork. The questionnaires were adapted from previously used tools from both the United Kingdom and New Zealand.[29-31]

Additionally, a random sample of caregivers of children registered at each practice was generated and the practice receptionist recruited to contact the caregivers of these children, aiming for a sample of 10 children per practice. Following informed consent, the caregivers completed a CATI exploring caregivers' education, antenatal primary care, and immunisation knowledge and attitudes. Their impression of the quality of primary care their child received was measured using the General Practice Assessment Survey.[32,33] Responses were aggregated by practice and expressed as the median or predominant response per practice.

Data analysis

The proportion of children registered at each practice who had received their scheduled immunisations on time was described. The proportion immunised was transformed to facilitate analysis using the arcsin of the square root of the variable. This transformation made the variance constant across the distribution of timeliness at each practice. Interaction with either region or practice governance for any of the variables associated with coverage was examined. The inverse of the number of enrolled children was used as a weight.

For the regression analyses a base model was created that included region (Auckland or Midland), practice governance (Maori or non-Maori), socioeconomic deprivation, and the median age and median age at registration of the children as explanatory variables. Explanatory variables that described practice characteristics, doctors, nurses and caregivers were then examined after adjustment for the effect on immunisation timeliness of these base-model variables. Multiple regression analyses were performed for each of these four areas, and then a summary analysis that combined variables from all four areas.

Results

The study sample (Figure 1) and recruitment (Figure 2) have been described previously, and the sample has been demonstrated to be regionally and nationally representative.[22,23,34]

Practice immunisation timeliness

A median (25th, 75th centile) of 56% (40%, 64%) of registered children at each practice were immunised on time. There was a wide distribution of timeliness across practices. Significant delay existed even for the first dose of DTaP-IPV and Hib-HepB due at six weeks of age where a median of 22% of registered children had delayed immunisation. This increased with each successive vaccination event (Table 2).

Factors associated with delay in immunisation

Socioeconomic deprivation, practice funding and whether urban or rural

Immunisation timeliness varied with socioeconomic deprivation of the practice population (the greater the deprivation the less likely that immunisations were delivered on time) but not with type of practice funding, or rurality. Practices with a smaller proportion of registered patients from socioeconomically deprived households delivered immunisations on time to a larger proportion of children ($p<0.001$)—see Table 3.

Characteristics of the practice

Timeliness decreased as age of the children at registration increased ($p=0.03$) and as the child's age increased ($p=0.004$). Timeliness was higher at practices where the electronic practice management system MedTech (Medtech Limited, Auckland, NZ) was used rather than one of the three alternative electronic systems ($p=0.01$). Practice staff shortages were associated with less timely immunisation delivery ($p=0.04$)—see Table 4.

Health professional characteristics

Immunisation delivery was more timely in practices where nurses perceived parental apathy to be a barrier to immunisation ($p=0.008$) and where the doctors perceived parental apathy to be a barrier ($p=0.002$).

Caregiver characteristics

Practice coverage was more timely where the caregivers had not received discouraging information about immunisation during the antenatal period ($p=0.04$). Coverage was also higher at practices where more caregivers had a tertiary qualification ($p=0.06$).

*Table 2. Percentage of the registered children at each of the practices not on time for each immunisation**

Scheduled vaccine	Median % of children delayed (5^{th}, 95^{th} centile)
6-week immunisations	
DTaP-IPV#1	22 (7, 67)
Hib-HepB #1	23 (8, 67)
3-month immunisations	
DTaP-IPV#2	27 (10, 67)
Hib-HepB #2	27 (11, 67)
5-month immunisations	
DTaP-IPV#3	30 (14, 73)
HepB 5M	30 (15, 77)
15-month immunisations	
DTaP-Hib	42 (19, 75)
MMR#1	44 (20, 75)

* An immunisation was defined as delayed (not on time) if not given within four weeks of the due date for vaccines scheduled at age six weeks, and within six weeks of the due date for vaccines scheduled at three months, five months and 15 months of age.

DTaP-IPV—diphtheria, tetanus, acellular pertussis, inactivated polio vaccine

Hib-HepB—Haemophilus influenzae type B, hepatitis B

MMR—measles, mumps and rubella

Multivariable model including practice, health professional and caregiver characteristics

The multivariable model explained 68% of the variance in immunisation timeliness between practices. In this multiple regression model of demographic, practice, nurse, doctor and caregiver associations with practice on-time immunisation, timeliness was higher in practices where there were no staff shortages ($p=0.01$), and that enrolled children at a younger age ($p=0.02$), where the nurse believed parental apathy to be a barrier ($p=0.008$), where the physician believed parental access was a barrier ($p=0.002$), and lower in practices with Maori governance ($p=0.05$), higher social deprivation ($p<0.001$) and where caregivers received information discouraging them from immunising ($p=0.04$)—see Table 5.

Discussion

There are many factors that contribute to timeliness of immunisation delivery. However, the relative contribution of each of these has not been explored previously. This study provides information on general practice characteristics and systems, health professional and caregiver factors and their relative contribution to the timeliness of immunisation delivery in children under two years in two major regions in New Zealand. It demonstrates the strong influence of social deprivation on practice immunisation delivery, but shows that independent of this effect there are practice, health professional and caregiver-specific issues that determine how well an individual practice delivers immunisations to its population.

The three major contributors to incomplete immunisation documented to date are socioeconomic factors, health care system factors and family and child factors.[35]

Immunisation timeliness has neither received as much focused attention nor been measured as intensely as absolute coverage. Additionally, most studies examining this issue in developed countries have been conducted in the United States.

Table 3. Practice immunisation timeliness by socioeconomic deprivation, practice funding and whether an urban or rural practice

Variable (number of practices)	**Median % of children at each practice with immunisations on time (25th, 75th centile)**				**p value***
Region	**Auckland**		**Midland**		
Governance	**Maori**	**Non-Maori**	**Maori**	**Non-Maori**	
Number of practices	**n=7**	**n=61**	**n=14**	**n=36**	
Percentage of registered patients in most socioeconomically deprived quintile† (118)					
Less than 30% (86)	39 (30, 47)	60 (47, 68)	62 (9, 64)	59 (47, 63)	< 0.001‡
30% or more (32)	32 (23, 42)	50 (20, 61)	40 (25, 47)	61 (27, 64)	
Access funding§ (118)					
No (72)	||	60 (47, 68)	64 (64, 64)	59 (47, 63)	0.59¶
Yes (46)	32 (23, 47)	56 (33, 64)	40 (25, 47)	60 (47, 62)	
Urban or rural practice (110)**					
Urban (90)	37 (25, 45)	61 (46, 68)	36 (25, 62)	59 (50, 65)	
Rural (20)	23 (23, 23)	49 (47, 57)	46 (45, 47)	60 (27, 63)	0.43¶

* Analysis adjusted for region and governance

† Percentage in most socioeconomically deprived quintile included in model as a continuous variable

‡ Based on the NZDep2001 index of deprivation; a small area-based measure that combines nine variables from the 2001 census which reflect aspects of material and social deprivation[28]

§ A practice is eligible for access funding if 50% of enrolled patients are from high-deprivation communities or are of Maori or Pacific ethnicities

|| No practices in this category

¶ Adjusted for region, practice governance and socioeconomic deprivation of the registered population

** As defined by a national rural ranking scale[49]

Table 4. Practice immunisation timeliness by characteristics of registered children and of the practice

Variable (number of practices)	**Median % of children at each practice with no delayed immunisations (25th, 75th centile)**				**p value[*]**
Region	**Auckland**		**Midland**		
Governance	**Maori**	**Non-Maori**	**Maori**	**Non-Maori**	
Number of practices	**n=7**	**n=61**	**n=14**	**n=36**	
Characteristics of the registered children <2 years old					
Median age of children (118)					
Less than 13 months (48)	38 (30, 46)	62 (56, 66)	49 (44, 57)	62 (57, 64)	0.004
13 months or older (70)	32 (23, 42)	49 (38, 67)	31 (25, 47)	55 (42, 61)	
Median age of children at registration[†] (118)					
Less than 3 months (72)	–[‡]	61 (45, 68)	25 (13, 52)	59 (47, 63)	0.03
3 months or older (46)	32 (23, 46)	55 (44, 62)	43 (31, 47)	58 (47, 63)	
Number of registered children[†] (118)					
Less than 150 (71)	31 (27, 39)	61 (45, 68)	42 (25, 50)	59 (46, 65)	0.64
150 or more (47)	42 (17, 47)	57 (44, 65)	47 (31, 62)	59 (50, 62)	
Characteristics of the practice					**p value[§]**
Medtech is patient management system used (117)					
Yes (89)	36 (23, 46)	62 (50, 67)	44 (31, 52)	59 (50, 63)	0.01
No (28)	32 (32, 32)	45 (33, 61)	19 (11, 46)	47 (42, 63)	
Practice charges for appointments for registered children (117)					
No (86)	32 (23, 46)	55 (40, 67)	40 (25, 47)	58 (46, 65)	0.24
Yes (31)	–[‡]	62 (59, 68)	64 (64, 64)	60 (57, 62)	
>15% of registered patients at the practice owed money[†] (116)					
Yes (43)	37 (30 46)	49 (43, 64)	42 (30, 62)	53 (39, 64)	0.18
No (73)	23 (23 23)	62 (49, 70)	36 (17, 50)	60 (49, 63)	
Practice has specific immunisation clinics or appointments (119)					
Yes (41)	30 (23, 46)	60 (46, 67)	40 (31, 62)	55 (47, 63)	0.43
No (78)	37 (25, 45)	55 (44, 67)	43 (25, 52)	59 (47, 63)	
Practice has staff shortages (117)					
Yes (76)	36 (23, 46)	57 (44, 66)	40 (25, 47)	58 (47, 63)	0.04
No (41)	32 (32, 32)	61 (46, 67)	62 (9, 64)	61 (57, 65)	

[*] Adjusted for region, practice governance and socioeconomic deprivation of the registered population

[†] Entered into model as continuous variable

[‡] No practices in this category

[§] Adjusted for region, practice governance and socioeconomic deprivation of the registered population, age and registration age of children <2 years old

With the potential to eradicate or better control diseases such as Haemophilus influenzae type B and pertussis it is necessary to shift the goal posts from coverage to timely coverage. Immunisation Registers make the regular monitoring and reporting of immunisation timeliness along with coverage more feasible. In order to be able to make use of this data to improve practice immunisation delivery it is necessary to determine what the features are of practices that achieve timelier immunisation delivery.

After adjustment for region, Maori governance, social deprivation and age of the child we found several other important determinants. Within the practice, staff shortages and the type of practice management system influenced coverage. Maintaining stable practice staff and, to a lesser extent, the type of management system that facilitates the systematic management of immunisation data and recalls appear to result in more timely immunisation delivery. Practices which registered their population of child patients at a younger age achieved more timely immunisation. While this appears intuitive, it is an important issue in New Zealand where the majority of antenatal primary care is provided by midwives, and it is necessary for the mother of a newborn child to then identify a family practice for Well Child care. Prompt transition between these two components of the primary care system is clearly necessary to achieve a good start to the immunisation components of this Well Child care.

Both the practice nurse and physician perception of caregiver barriers was associated with more timely immunisation delivery by the practice. This could be an indirect measure of a type of health professional who is more interested and engaged with immunisation issues at their practice and also more aware of the issues facing the populations they serve. It has been previously shown that confident, engaged providers support improved immunisation coverage.[12,36]

Anti-immunisation material from various sources discouraging caregivers from immunising their children has frequently been shown to affect coverage.[37–39] Of all caregiver variables measured in this study, receipt of discouraging information in the antenatal period was the only one to remain significant after controlling for all likely confounders. This emphasises the importance of the antenatal period as a time when promotion of immunisation must occur as well as limiting the exposure to anti-immunisation material.[40]

Relationship to international literature

Most studies reporting timeliness have been conducted in the US[41–44] as well as surveys of

Table 5. Combined analysis of practice, child, health professional and caregiver associations with practice immunisation timeliness

Variable*	Direction of effect on timeliness	ß-coefficient	p value
Demographics			
Governance	More timely in non-Maori than Maori governance practices	-0.0868	0.05
Socioeconomic deprivation	Less timely with increased socioeconomic deprivation	-0.0025	<0.001
Practice			
Age of children at registration	Less timely with increasing age at registration	-0.0009	0.02
Staff shortages	More timely in practices that did not have staff shortages	-0.0770	0.01
Nurse			
Nurse perceives parental apathy as barrier to immunisation	More timely in practices where nurse had this perception	0.0819	0.008
Doctor			
Doctor perceives parental access difficulties as a barrier	More timely in practices where doctor had this perception	0.1090	0.002
Caregiver			
Received discouraging information about immunisation antenatally	Lower at practices where caregivers received discouraging information	-0.0643	0.04

* Other variables in model for which associations with coverage were not significant:

- region (p=0.96)
- age of registered child (p=0.30)
- patient management system used (p=0.12)
- nurse to child ratio (p=0.73)
- doctor perceives parental apathy as a barrier (p=0.18)
- caregiver has a tertiary qualification (p=0.06)

Australian clinical records using national register data[45] and well-baby records in Sweden.[46] A comparison of international studies reported a range in delay in infant programmes from 6% (US)[43] to 75% (Australia).[45] There is a range of factors associated with timeliness reported in these studies.

Delay in commencing immunisation is associated with delay for later doses and incomplete immunisation.[36] We found that the increasing age of child at enrolment was inversely associated with coverage. Delay in enrolment at the general practice could lead to delay in uptake of the first vaccination.

Ethnicity, area of residence[16,47,48] and, in Sweden, negative media coverage was associated with delay in MMR vaccination.[46] Consistent with these findings, we specifically determined that region and social deprivation were important factors in determining coverage. Also, coverage was lower at practices where caregivers had received discouraging information.

Strengths and limitations

A strength of this study is that it involved a large population of 26 000 children under two years of age in a regionally representative sample of practices including urban and rural, serving a wide socioeconomic and ethnic spectrum. Immunisation data was obtained by an electronic audit of individual child immunisation data and so is, to the best of our knowledge, the most accurate measure of practice immunisation available. A comprehensive range of factors likely to impact upon practice immunisation delivery was measured, allowing the description of a complete picture of practice immunisation delivery.

Limitations include a practice decline rate of 38%. However, the sample is both regionally and nationally representative. We were limited to interviewing one GP and one nurse from each practice whose responses may not have been representative of all GPs and nurses at the practice. Seeking to interview multiple GPs and nurses would have been an unacceptably high respondent burden and would likely have resulted in a higher decline rate.

Implications and recommendations

A variety of factors at the primary care and health professional level contribute significantly to immunisation timeliness and, unlike most caregiver characteristics, are under greater control by the practice. This study has identified those practice characteristics that contribute most significantly to timely immunisation uptake.

Interventions that promote early enrolment of infants at a primary health care practice, sufficient stable staffing, committed and confident providers and a practice management system capable of managing immunisation information could facilitate improvements in the timeliness of immunisation uptake. Monitoring and managing anti-immunisation activity in the antenatal period could also mitigate the effects of discouraging information affecting immunisation uptake. Our study suggests that significant improvements in immunisation timeliness can be made within the primary care setting.

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Factors associated with immunisation coverage and timeliness in New Zealand

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ABSTRACT

Background
Immunisation coverage in New Zealand is lower than what is necessary to prevent large epidemics of pertussis. Primary care is where most immunisation delivery occurs. General practices vary in their structure and organisation, both in a general sense and specifically with respect to immunisation delivery.

Aim
To identify the structural and organisational characteristics of general practices associated with higher immunisation coverage and more timely immunisation delivery.

Design of study
A random sample of practices during 2005 and 2006.

Setting
General practices in the Auckland and Midland regions, with over-sampling of indigenous Maori governance practices.

Method
Practice immunisation coverage and timeliness were measured. Primary care practice characteristics relevant to immunisation delivery by the practice were described. Associations of these practice characteristics with higher practice immunisation coverage and more timely immunisation delivery were determined.

Results
A total of 124 (61%) of 205 eligible practices were recruited. A median (25th to 75th centile) of 71% (57–77%) of registered children at each practice were fully immunised, and 56% (40–64%) had no immunisation delay. In multivariate analyses, both practice immunisation coverage ($P<0.001$) and timeliness ($P<0.001$) decreased with increased social deprivation. After adjustment for socioeconomic deprivation, region, and governance, immunisation coverage and timeliness were better at practices that enrolled children at a younger age (coverage: $P = 0.002$; timeliness $P = 0.007$), used one of the four available practice management systems (coverage: $P<0.001$; timeliness: $P = 0.006$), and had no staff shortages (coverage: $P = 0.027$; timeliness: $P = 0.021$).

Conclusion
Practice immunisation coverage and timeliness vary widely in New Zealand. General organisational and structural aspects of general practices are key determinants of general practice immunisation delivery.

Keywords
delivery of health care; family practice; immunisation; primary health care.

INTRODUCTION

Immunisation is the most cost-effective intervention modern medicine has to offer.[1] To achieve the full benefits of immunisation, both high coverage and timely delivery of scheduled immunisations are necessary.

Immunisation coverage in New Zealand (NZ) is mediocre. In the 2005 national survey, only 77% of children at 2 years of age had received all scheduled childhood immunisations. Coverage for indigenous (Maori) and Pacific children is lower, despite the NZ Ministry of Health's goal of 95% for all.[2] As a consequence, NZ continues to experience large epidemics of pertussis. The infant pertussis hospitalisation rate is three to six times higher than contemporary rates for Australia, England, and the US.[3–6]

Timeliness of delivery is as important as coverage. Delay in receipt of the first vaccine dose in the primary series is one of the strongest predictors of subsequent incomplete immunisation.[7] Delay in

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receipt of any of the three infant doses of pertussis vaccine increases the risk of hospital admission with pertussis.[8]

Socioeconomic factors, healthcare system factors, and parental attitudes contribute to incomplete immunisation.[9] Research to date in NZ on immunisation coverage has focused on the characteristics of the child, family, or household. Internationally, it is well recognised that health systems and their providers make significant contributions to gaining and maintaining high coverage.[10,11] The identification of health system barriers has been an essential component of immunisation coverage improvements in Australia and the US.[12,13]

Most immunisation delivery occurs in primary care. While the attitude of healthcare providers is crucial to achieving maximal immunisation uptake, healthcare structural and organisation factors also determine immunisation delivery.[14] Aspects that have been identified as important include record keeping and documentation, recall/reminder, and tracking systems and practice settings.[15–17]

The aim of this study was to determine the structural and organisation characteristics of general practices that are associated with higher immunisation coverage and more timely immunisation delivery.

METHOD

Study design and setting

Approval was obtained from the Ministry of Health Ethics Committee. General practices in two NZ regions (Auckland and Midland) were enrolled during 2005 and 2006. Approximately 50% of all NZ children aged 0 to 4 years reside in the study region.

A random sample of practices was recruited, with stratification by region and oversampling of Maori governance practices (these are independent Maori health providers that target services primarily towards Maori and have a Maori management and governance structure).[18] There were 11 such Maori governance practices in Auckland and 50 in Midland.

A total of 213 of the 517 practices in the study region were selected. In Auckland this included all Maori governance practices plus a random 29% of the non-Maori governance practices. In Midland it included a random sample of 62% of the Maori governance practices and 61% of non-Maori governance practices. From this sample it was possible to recruit 124 practices: 72 from Auckland and 52 from Midland.

Sample size estimates

A total of 124 practices was sufficient to yield 80% power to show statistical significance at the 5% level for a practice characteristic associated with higher coverage or more timely immunisation delivery. These calculations assumed the characteristic being examined had a frequency between 10% and 70% and was present in 20–25% more of the practices with higher coverage or better timeliness.

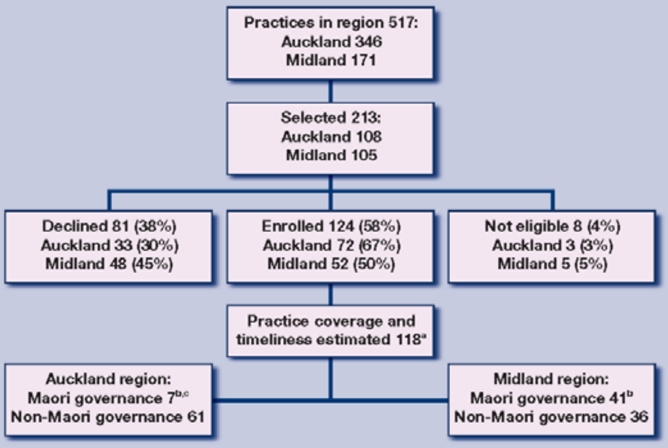
How this fits in

General practices are where most immunisation delivery occurs. Preventive health service delivery by practices requires appropriate structure and organisation. General organisational characteristics of practices (age when children registered, type of practice management system used, and stability of staffing) are key practice determinants of immunisation delivery. These areas, rather than more immunisation-specific factors, should be addressed first when seeking to improve general practice immunisation delivery.

Data collection and measurements

Practice immunisation coverage and timeliness were measured by electronic audit of the immunisation records for all children aged 6 weeks to 23 months. During this study the NZ immunisation schedule included a '6 week, 3 month, 5 month' primary series of diphtheria, tetanus, pertussis (DTaP); polio; *Haemophilus influenzae* type b (Hib); and hepatitis B vaccines and; at age 15 months, measles, mumps, rubella vaccine plus a booster dose of DTaP and Hib vaccines.[2]

'Practice structure and organisation' was defined as those aspects of the practice that were independent of the characteristics of a specific GP or practice nurse, but were liable to influence the care they delivered when working within that practice. These characteristics were divided into those relevant to all aspects of primary healthcare delivery by the practice and those that were specific to immunisation delivery. For example, characteristics relevant to all aspects of primary care delivery include the age at which children being seen at the practice were registered with the practice and whether or not the practice had staff shortages (that is, unfilled positions for doctors, nurses, or other practice staff). In NZ, when this study was conducted, patients could be seen as casual patients at any practice. Registration with the practice indicated that the practice was the provider of this child's preventive health care and that the practice would maintain a record of the health care received by the child. Examples of characteristics specific to immunisation delivery include whether the practice had specific immunisation clinics and whether GPs at the practice sometimes gave immunisations.



[a]At one practice none of the immunised children was registered. [b]Coverage and timeliness for four Auckland and three Midland Maori governance practices were estimated as one practice. [c]One Auckland Maori governance practice was not eligible.

Figure 1. Summary of practice recruitment and enrolment.

The practice structure and organisation was described from a face-to-face interview with the practice manager, lead GP, or senior practice nurse. Practice population demographics (ethnicity and socioeconomic deprivation) were obtained from the Ministry of Health. Socioeconomic deprivation was measured using the NZDep2001 Index of Deprivation, a small area-based measure that combines nine variables from the 2001 Census that reflect aspects of household material and social deprivation, and is used to group NZ households into socioeconomic quintiles or deciles.[19]

Immunisation coverage was measured based on the child's age in relation to the immunisation schedule. For example, a child aged 10 weeks was fully immunised if they had received all of the immunisations scheduled to be given at age 6 weeks, and a child aged 6 months was fully immunised if they had received all of the immunisations scheduled to be given at age 6 weeks, 3 months, and 5 months.

Immunisation coverage was defined using the third dose assumption. If the third in a series of vaccine doses was recorded as given, then it was assumed that the previous doses had also been given.[20] This assumption results in a small overestimate of coverage that is less than the underestimate that occurs if only recorded doses are counted.[20]

The Ministry of Health's National Immunisation Register definition of timeliness was used.[21] An immunisation was defined as delayed if not received within 4 weeks of the first due date for the 6 week immunisations, and within 6 weeks for 3 month, 5 month, and 15 month immunisations.[21]

Data analysis

Immunisation coverage and timeliness were described for the children aged 6 weeks to 23 months registered at each practice. The proportion of children fully immunised and the proportion with no delayed immunisation were transformed to facilitate analysis using the arcsin of the square root of the variable. This transformation made the variance constant across the distribution of coverage and number of children at each practice. Examination was carried out for interaction with either region or practice governance for any of the variables associated with coverage. Variables for which such interaction was present were not included in the statistical models.

A general linear model was created with arcsin of the square root of the proportion immunised as the outcome variable. For the regression analyses a base model was created that included region, practice governance, socioeconomic deprivation, and the age, and age at registration, of the children as explanatory variables.

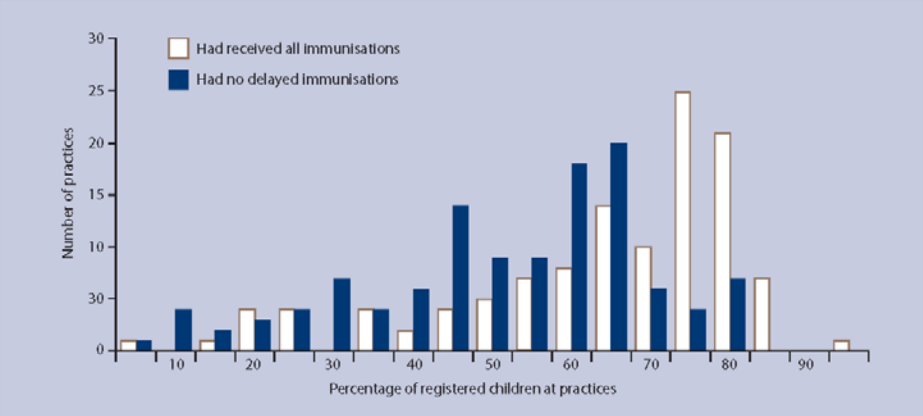


Figure 2. Immunisation coverage and timeliness by practice.

Additional explanatory variables that described practice structure and organisation were then added to this model. Practice structure and organisational variables were retained in the final models of coverage and timeliness if they increased the model's explanatory power or remained significantly associated with practice coverage or timeliness. Analyses were performed using SAS (version 9.1; SAS Institute, Cary, NC, US).

RESULTS

Practice recruitment

There were 517 practices in the study region. A total of 213 practices (41%) were randomly selected: 108 (31%) in Auckland and 105 (61%) in Midland. A small number of practices were ineligible, mainly because they did not provide Well-Child care. Thirty-nine per cent of selected practices declined to participate. The percentage of practices that declined was higher in Midland than Auckland (45% versus 30%, P = 0.015). Practices that declined to participate were smaller (mean number of registered patients 3644 versus 4339) and had a larger proportion of registered patients living in the most deprived quintile of households (26% versus 24%, $P<0.001$; see Figure 1).

Practice immunisation coverage and timeliness

The median (25th to 75th centile) number of children aged 6 weeks to 23 months registered at each practice was 116 (62–193); with these registered children being 75% (64–88) of all children in this age group seen at each practice. A median (25th to 75th) percentage of 71% (57–77%) of the children registered at each practice were fully immunised and 56% (42–64%) were not delayed for any immunisations. The percentage of children registered at each practice that had received all immunisations and were not delayed varied widely (Figure 2). Practice immunisation coverage and timeliness were highly correlated (Spearman's rank correlation coefficient $r = 0.77$, $P<0.001$).

Regional, governance, socioeconomic, and age-related factors

Practice immunisation coverage ($P<0.001$) and timeliness (P = 0.002) both decreased as the socioeconomic deprivation of the registered practice population increased (Table 1). Practice coverage was higher in Midland than Auckland (73% versus 68%, P = 0.004). Immunisation timeliness was lower at Maori governance practices versus non-Maori governance practices (P = 0.03). Younger age at registration was associated with higher immunisation coverage (P = 0.02) and more timely immunisation delivery (P = 0.02). Coverage decreased with increasing age of the child ($P<0.001$).

Generic practice organisational features

Four different electronic practice management

Table 1. Associations of region, practice governance, socioeconomic deprivation, child's age, and child's registration age with practice immunisation coverage and timeliness.

	Immunisation coverage			Immunisation timeliness		
Practice characteristic (number of practices)	Median % (25th to 75th centile)	Univariate *P-value*	Multivariate *P-value*[a]	Median % (25th to 75th centile)	Univariate *P*-value	Multivariate *P*-value[a]
Region						
Auckland (68)	68 (53–75)	0.020	0.004	55 (41–66)	0.250	0.350
Midland (50)	73 (58–79)					
Practice governance						
Maori (21)	56 (44–62)	0.006	0.110	40 (25–47)	0.002	0.030
Non-Maori (97)	73 (63–79)			59 (47–66)		
	P-value adjusted for region and governance			*P*-value adjusted for region and governance		
% of registered patients in most deprived quintile[b]						
<30% (86)	74 (63–79)	<0.001	<0.001	60 (47–66)	<0.001	0.002
≥30% (32)	58 (35–65)			42 (25–58)		
Median age of registered children at each practice						
<13 months (48)	73 (65–78)	0.001	<0.001	61 (54–66)	0.001	0.560
≥13 months (70)	64 (49–77)			48 (34–63)		
Median age of children at registration						
<3 months (72)	74 (63–79)	0.040	0.020	60 (46–66)	0.140	0.020
≥3 months (46)	63 (46–73)			47 (35–62)		

[a] Adjusted for other variables in table with socioeconomic deprivation, age, and age at enrolment all entered into model as continuous variables. [b] Percentage in most socioeconomically deprived quintile included in model as a continuous variable. Socioeconomic deprivation measured using the NZDep2001 Index of Deprivation, a small area-based measure that combines nine variables from the 2001 Census that reflect aspects of material and social deprivation.[19]

Table 2. Associations of practice structure and organisation with practice immunisation coverage and timeliness.

	Coverage			Timeliness		
Practice characteristic (number of practices)	Median % received all immunisations (25–75th centile)	*P*-value adjusted for region and governance	*P*-value adjusted for region, governance, social deprivation[a], age and age at registration	Median % with no delayed immunisations (25–75th centile)	*P*-value adjusted for region and governance	*P*-value adjusted for region, governance, social deprivation[a], age, and age at registration
Generic practice factors						
Practice management system used						
Medtech32 (89)	72 (62–78)	<0.001	0.001	59 (46–64)	<0.001	0.010
Other (28)	63 (44–76)			42 (25–60)		
Staff shortages						
Yes (76)	67 (53–75)	0.010	0.100	50 (37–63)	0.007	0.040
No (41)	76 (65–79)			61 (44–66)		
Practice charges for visits by registered patients						
Yes (31)	75 (70–82)	<0.001	0.200	49 (35–64)	0.002	0.240
No (86)	65 (52–75)			61 (57–64)		
Percentage of patients owing money to practice						
>15% (43)	62 (47–73)	<0.001	0.270	47 (32–62)	<0.001	0.180
≤15% (73)	75 (65–80)			60 (47–66)		
Immunisation-specific practice factors						
Specified appointments or clinics for immunisation						
Yes (40)	69 (59–77)	0.030	0.270	57 (43–64)	0.050	0.430
No (77)	71 (57–77)			55 (38–64)		
GPs sometimes give the immunisations						
Yes (44)	70 (64–79)	0.110	0.580	60 (46–66)	0.020	0.200
No (73)	70 (54–75)			55 (32–62)		
Frequency of immunisation audit						
At least monthly (32)	72 (62–77)	0.005	0.250	58 (47–62)	0.070	0.900
Less often (85)	70 (56–77)			51 (37–65)		

[a]Percentage in most socioeconomically deprived quintile included in model as a continuous variable. Socioeconomic deprivation measured using the NZDep2001 Index of Deprivation, a small area-based measure that combines nine variables from the 2001 Census that reflect aspects of material and social deprivation.[19]

systems were used, with one system (Medtech32, 2008, Medtech Global Ltd, Auckland, NZ) being predominant ($n = 89$; 76%). After adjustment for region, governance, social deprivation, and age, immunisation coverage ($P = 0.001$) and timeliness ($P = 0.01$) were higher at practices that used Medtech32 (Table 2).

Approximately two-thirds of practices ($n = 76$, 65%) experienced staff shortages, with such staffing issues being associated with less timely immunisation delivery ($P = 0.04$).

While all childhood immunisation visits were free, practice charges for other visits ranged from $0 to $30 for children <6-years old, and from $0 to >$60 for adults. The majority of practices were owed money by their registered patients. At 41 practices (35%) less than 5% of patients owed money, at 32 (28%) 5–15% owed money, and at 43 (37%) more than 15% of patients owed the practice money.

In univariate analyses both coverage and timeliness were higher at practices that charged for visits and at practices where 15% or less of patients owed money. These associations were no longer evident after adjustment for socioeconomic deprivation.

Immunisation-specific practice organisational features

Practices varied with respect to their immunisation-specific characteristics. One-third of practices ($n = 40$, 34%) had specific clinics or allocated appointments for immunisation. At 44 practices (38%), GPs sometimes gave immunisations. Immunisation audits were completed at least monthly at 32 (27%) practices. After adjustment for region, governance, socioeconomic deprivation, child's age, and age at registration, none of these immunisation-specific practice features were associated with coverage or timeliness. (Table 2).

Multivariate analysis of generic and immunisation-specific practice characteristics

Multivariate models describing the specific practice characteristics and their associations with practice immunisation coverage and timeliness were created by the addition of these variables to the base model described (region, practice governance, social deprivation, child's age, and age at registration). In this multivariate analysis, immunisation coverage varied by region ($P = 0.002$) and was lower in practices whose registered population was more

Table 3. Multivariate analysis of practice structure and organisation factors and their associations with practice immunisation coverage and timeliness.

	Practice immunisation coverage[a]		Practice immunisation timeliness[b]	
	Coefficient (95% CIs)	*P*-value	Coefficient (95% CIs)	*P*-value
Region				
Auckland	−0.091 (−0.147 to −0.036)	0.002	−0.029 (−0.083 to 0.026)	0.31
Midland	–		–	
Practice governance				
Maori	−0.073 (−0.155 to 0.001)	0.09	−0.096 (−0.177 to −0.015)	0.02
Non-Maori	–		–	
% of registered patients in most socioeconomically deprived quintile[c]	−0.003 (−0.004 to −0.001)	<0.001	−0.003 (−0.003 to −0.003)	<0.001
Median age of children at practice	−0.001 (−0.001 to 0.000)	0.13	0.001 (0.000 to 0.001)	0.046
Median age of children at time of registration with practice	−0.001 (−0.002 to −0.001)	0.002	−0.001 (−0.001 to −0.001)	0.007
Practice management system used				
Medtech32	0.215 (0.105 to 0.324)	<0.001	0.154 (0.047 to 0.26)	0.006
Other	–		–	
Practice experiences staff shortages				
Yes	−0.074 (−0.138 to −0.010)	0.027	−0.076 (−0.139 to −0.013)	0.02
No	–		–	

[a]Data from 95 practices in multivariate model, r^2 for model = 0.60. [b]Data from 95 practices in multivariate model, r^2 for model = 0.45. [c]Socioeconomic deprivation measured using the NZDep2001 Index of Deprivation, a small area-based measure that combines nine variables from the 2001 Census that reflect aspects of material and social deprivation.[19]

socioeconomically deprived ($P<0.001$). Coverage was higher at practices where children were registered at a younger age ($P = 0.002$), used Medtech32 as their practice management system ($P<0.001$), or did not experience staff shortages ($P = 0.027$). Timeliness was lower at Maori governance practices ($P = 0.020$) and at practices whose registered population was more socioeconomically deprived ($P<0.001$). Timeliness was higher for practices with populations with younger children ($P = 0.046$), at practices where children were registered at a younger age ($P = 0.007$), at practices that used Medtech32 as their practice management system ($P = 0.006$), and at practices that did not experience staff shortages ($P = 0.021$; Table 3).

DISCUSSION

Summary of main findings

Both immunisation coverage and timeliness varied widely in this sample of NZ general practices. Median percentages of children registered at each practice that were fully immunised (71%) and not delayed for any immunisations (56%) were both too low to realise the full health benefit from a national immunisation schedule.

In multivariate analyses, the practice structure and organisational factors associated with immunisation coverage and timeliness were similar. Socioeconomic deprivation of the enrolled practice population was a dominant factor in both multivariate models. For both coverage and timeliness, three practice characteristics were significant: younger age at registration, use of one of four available practice management systems, and not having staff shortages. None of the immunisation-specific practice factors explained any additional variance between practices in immunisation coverage or timeliness.

Strengths and limitations of the study

The immunisation audit was completed at each practice using computer programmes developed specifically for this purpose. Thus, an independent measure of practice immunisation delivery was obtained. For each practice this was a single point estimate and, therefore, less precise than one based on repeated measures, especially for smaller practices.[22] Because of this, the regression analysis used a transformed dependent variable, with this transformation making the variance constant across the range of practices sizes.

The response rate among eligible practices was 61% and the final multivariate models of immunisation coverage and timeliness included only 95 (45%) of 213 invited practices. This project coincided with a national meningococcal immunisation strategy and a large practice accreditation process in Midland; both affected practices' ability to engage with this project. Practices struggling to cope with these competing issues may have been less likely to participate in this study. Such non-participation could in part explain the higher practice coverage in the Midland region.

Although oversampling of Maori governance practices added complexity to the data analysis, it did ensure the study included practices serving populations for whom immunisation coverage is lower.[2] If Maori governance practices had not been actively recruited, the enrolment bias towards practices that served a less socioeconomically deprived population would have been greater. Thus the authors believe the study sampling strategy helped to include a broad spectrum of practices and hence increased the generalisability of the study findings to the study region.

Comparison with existing literature

Practice registration at a younger age increases the likelihood that the first doses of the primary immunisation series are delivered on time. Timely delivery of this first immunisation is one of the strongest predictors of subsequent completion of the immunisation series.[7] National immunisation registers can aid the early enrolment of a child with the practice.[23] NZ introduced a national immunisation register in 2005. The present study indicates that one priority for this register must be to facilitate early enrolment of newborn infants with their primary care provider. Early enrolment is likely to lead to a stronger relationship between the practice and family. This is of particular importance in NZ where perinatal primary care is fragmented. Primary health care during pregnancy and post-partum is delivered predominantly by midwives, and the timing of transition of infant care responsibility from midwife to GP varies.

To improve immunisation delivery practice, management systems need to have a functionality that extends beyond enabling the practice to claim reimbursement for immunisations given. The quality of data in the national immunisation register is dependent on the quality of data transferred from the practice management system. Practice management systems that are used to report immunisation data are not designed specifically for this purpose. Considerable variability was observed between the different practice management systems, in terms of staff competence and confidence with the system and the ease of access that practice staff had when technical support was required.[24]

As was found in this project, and as has been shown in other primary care practices in NZ, the quality of immunisation data that such systems report is variable.[24,25] Practice management systems used in NZ have design features that can minimise data entry errors. However, currently, the systems enable users to alter these features, thus introducing practice-level variability in recording of immunisation data.

Preventive health service delivery is particularly vulnerable to staff shortages and high staff turnover. Understaffed practices do not have the time or the consistency of personnel to reflect upon their work and adopt a proactive rather than a reactive approach to service delivery issues. General practices in NZ do have a preventive service orientation, but there is variability in how well individual practices use their practice management systems to support immunisation delivery. Important aspects include office coordination of preventive services, a system to ensure all visits become preventive care opportunities, and regular performance monitoring.[26]

Staffing shortages may also reflect broader issues of organisational culture and practice leadership. They reflect how people work together, communicate, and resolve conflict within a general practice.[26] Staff shortages are financially costly for a practice, with the resources spent on recruitment and training not available for service delivery.[27]

The socioeconomic deprivation of the practice population was a consistently strong determinant of practice immunisation delivery in both the coverage and timeliness models. Poverty and factors related to poverty are recognised as being among the more persistent barriers to immunisation.[13,28] The significance of this for children living in poorer households is increased by such households also being places where exposure to vaccine-preventable disease is increased.[29]

The relationship between socioeconomic deprivation and practice immunisation delivery appears to be specific rather than a more general feature across all indicators of quality of primary care.[30] This is probably a reflection of immunisation-specific issues. Examples of such issues include the necessity for multiple appointments to receive the complete immunisation series, and the contribution of missed immunisation opportunities that occur at acute illness visits.[31,32] Children living in more socially deprived households have more frequent episodes of acute illness. Healthcare visits for such illnesses account for the majority of missed immunisation opportunities.[32]

Implications for clinical practice

Wide variability between primary care practices in preventive service delivery to children is acknowledged as a current weakness of primary care in the US.[33] This study indicates that such variability is also a current weakness of primary care in NZ. Important practice characteristics include staffing levels and stability, practice orientation to preventive services, and adaptation to the population context in which preventive service delivery occurs.[26]

This study implies that these basic issues of primary care structure and organisation need to be addressed to obtain full return on immunisation-specific initiatives.

Funding body

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Ethical approval

Approval was obtained from the Ministry of Health Northern X Ethics Committee. AKX/04/09/265 'General practice and health professional determinants of immunisation coverage'.

Competing interests

Cameron C Grant completed a consultancy on rotavirus gastroenteritis for GlaxoSmithKline during 2005 and 2006. Nikki M Turner, Deon G York, Felicity Goodyear-Smith, and Helen A Petousis-Harris have no competing interests to declare. None of the authors has any financial interest in any of the practice management systems used by the practices enrolled in this study.

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Seize the moments: missed opportunities to immunize at the family practice level

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Turner N, Grant C, Goodyear-Smith F and Petousis-Harris H. Seize the moments: missed opportunities to immunize at the family practice level. *Family Practice* 2009; **26**: 275–278.

Background. Missed immunization opportunities (MOs) are a significant barrier to achieving high immunization coverage.

Objective. To describe the nature of MOs to immunize within primary care in New Zealand and their effect on immunization completeness.

Methods. Audit of medical records of ~10 randomly selected children <2 years old from each of 62 primary care practices in Auckland, New Zealand.

Results. The 616 audited children made 10 094 visits to primary care practices. MOs occurred at 97% (60) of practices, in 556 (5.5%) of visits, and 31% of the children had one or more visits that were an MO. Overall, children who had any recorded MO visit were 3.1 times more likely to be incompletely immunized than children who had no recorded MO (95% CI 1.87–5.14). Children with the greater percentage of overall visits that were MOs had up to a 9 times increased likelihood of incomplete immunization compared to those who had no MO visits. Nurse visits have less MOs than doctor (1.5% versus 6%) but are more likely to occur within well-child visits.

Conclusions. MOs are common in primary care practices, occurring in nearly one-third of visiting children. The risk of under-immunization increases with the increasing percentage of visits that are MOs. Overall strategies directed at reducing MOs need to focus on a range of aspects for the practitioner and the practice system.

Keywords. Family practice, immunization, missed opportunities, primary health care, vaccination.

Background

Childhood immunization is one of the most cost-effective activities in health care.[1] Failure to deliver scheduled vaccines in a timely manner results in disease epidemics.[2–4] Improvements in the infrastructure of immunization service delivery are key to the increase in immunization coverage.[5–7]

Missed immunization opportunities (MOs) are a significant health care system factor contributing to incomplete immunization.[8] MOs are defined as health care visits where children do not receive an immunization when they are age eligible for the vaccine with no contraindication present.[9] MOs are estimated to occur in 20–84% of all child health care visits[10] contributing to 13–40% of total under-vaccination.[11]

Objectives

The study objectives were to describe the frequency and characteristics of MOs to immunize within the New Zealand primary health care setting and to estimate the contribution MOs make to incomplete immunization.

Methods

Design

A patient record audit, as part of a larger project examining family practice and health professional determinants of immunization coverage.[12, 13]

Setting

Seventy-two randomly selected primary care practices from a 2005 database of 346 practices within

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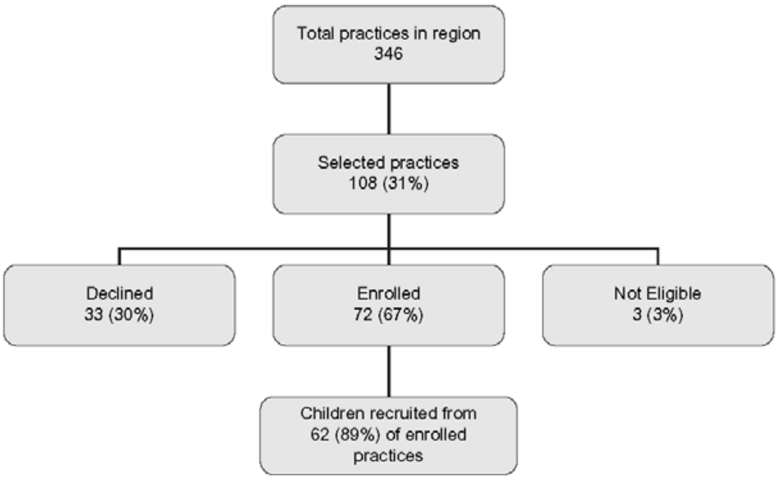

FIGURE 1 *Summary of family practice recruitment collection*

metropolitan Auckland, New Zealand (population ~1.2 million).

Subjects

Ten children aged between 6 weeks and 24 months were randomly selected recruited from the patient database of all eligible children enrolled at each study practice. Practice staff obtained written informed consent from their parents.

Outcome measures

Immunizations received by each child were determined by an electronic audit of each practice management system. Children were defined as completely immunized if they had received all New Zealand schedule immunizations due as defined by the child's age (6 weeks, 3, 5 and 15 months).[3]

The definition of a true contraindication was based on the New Zealand standard definition[3] which includes anaphylaxis to a prior dose or component of the vaccine, moderate or severe illness with a temperature 38°C (100°F) and specific contraindications to specific vaccines.

The medical notes of all recruited children were retrospectively audited. Recorded visits were documented. Visits that fell within a date period when an immunization event was due but not given were recorded along with the diagnosis and any contraindication, based on the clinical notes.

Data analysis

MOs and immunization completeness for each child were described. Associations of MO with immunization completeness were determined using odds ratios and 95% confidence intervals. Because children were enrolled in groups from each practice, these analyses were adjusted for clustering by practice using SAS-PC version 9.1 (SAS Institute, Cary, NC) and SAS callable SUDAAN version 9.0.1 (Research Triangle Institute, Research Triangle Park, NC).

Results

Practice recruitment is summarized in Figure 1. Sixty-two of the 72 practices enrolled (89%) consented caregivers for the audit. The remaining eight practices lacked time or available staff to undertake recruitment.

There were 661 children recruited (range 8–18 per practice), of whom 655 had complete information. The variance in number recruited per practice was due to some practices sending out >10 requests and accepting all.

Audit of these 655 children's records identified 10 094 visits to the practice (median 15 visits per child). Of these visits, two-thirds (6797) were to the family physician and one-third (3297) to the practice nurse. Sixteen per cent (1614) were joint visits to both. Overall, 6% (556) of all visits resulted in an MO, and MOs occurred at 97% (60) of the practices.

Of the 2002 children who had MOs, 20% (40) occurred when the first, 14% (28) when the second, 27% (55) when the third and 40% (80) when the fourth immunization event was due.

Characteristics of visits where MOs occurred

Overall, 80% (447) of MOs were with acute care visits: respiratory tract illnesses, 37% (166); acute otitis media, 9% (54); non-specific viral illnesses, 5% (31); skin infections, 5% (30); gastroenteritis, 5% (28); eczema, 4% (20). Together these six conditions accounted for 65% of acute visits where MOs occurred.

Nurse versus doctor visits

Practice nurses had a significantly smaller proportion of MOs per overall visits than family physicians. Fifty of 3297 nurse visits (1.5%) resulted in MOs, compared with 399 (6%) of physician visits (chi-square = 176, $P \leqslant 0.001$).

Well-child visits resulted in 35 (70%) of MOs for nurses compared to only 18 (5%) of physicians, whereas 365 (91%) of the doctor MOs were related to acute illness or injury presentations (chi-square = 183, $P < 0.001$).

Presence of contraindications at MO visits

True contraindications were present at 5% (28) of visits occurring within the time window of an MO, with possible contraindications in a further 4%. Most true contraindications (89%, 25 cases) were fever (temperature >100°F).

Associations between MOs and immunization completeness

Overall, children who had any recorded MO visit were 3.1 times more likely to be incompletely immunized than children with no recorded MO (1.87–5.14). Children for whom >20% of all their visits were MOs had 9.11 (4.35–19.38) times increased risk of being incompletely immunized compared with children who had no recorded MO visits (Table 1).

Conclusions

MOs to vaccinate children occur in most practices, for nearly a third of children visiting a primary care practitioner and are strongly associated with incomplete immunization.

Consistent with other studies, MO visits are more common with acute illness visits.[14] The main focus of an acute illness visit will be on the presenting complaint and both parents and physicians may not wish to vaccinate an acutely unwell child regardless of the lack of contraindication. However, follow-up visits are scheduled after many acute care consultations and provide opportunities to consider and offer immunizations.

The different pattern seen between doctors and nurses has not been noted in other literature and is likely to be due to the different nature of the visits rather than differences in knowledge, with physician visits more likely to be due to acute illnesses. New Zealand family physicians and practice nurses have demonstrated similar knowledge gaps particularly in relation to identifying contraindications.[15]

Greater barriers to MOs may be related to issues at the encounter rather than poor provider knowledge; such as the priority of the acute presentation taking precedence, the concerns over lack of certainly about how the acute illness will evolve and practice system issues, in particular failure to raise the attention of all staff at all encounters to the overdue immunization.

Vigilance by all staff to MOs, education around false contraindications and an effective organizational approach in general practice are the key elements to reducing MOs. A well-organized practice has an electronic practice management system to flag to all members of the practice team, at all encounters, that a child is due/overdue an immunization event. With a systematic approach and good teamwork, at each encounter the provider can offer brief advice and immediate referral of the child for vaccination at the time if desired.

Children with high rates of incomplete immunization are frequently called 'hard to reach'. However, these children are accessible in that they are frequently attending the primary care provider. Improving focus on opportunistic immunization with visits at the provider level may have greater gains than relying on a multiple stepped recall system.

Potential gains from reducing MOs are considerable. In the USA, it has been estimated that elimination of MOs would decrease total under-vaccination by 50% and increase coverage levels up to 30%.[16]

Overall strategies directed at reducing MOs need to focus on a range of aspects for the practitioner and the practice system. These include practice systems to raise the profile of overdue immunizations at every

Table 1 *Associations of MOs with immunization completeness and timeliness*

Age group	Children with any MO visit recorded Incomplete immunization[a] *n* (*N*) %	Children with no recorded MO visit Incomplete immunization[a] *n* (*N*) %	Odds ratio (95% CI) of a child with any MO having incomplete immunization compared to a child with no MO[a]
6 weeks to <3 months	1 (8) 12.5%	1 (5) 4%	3.29 (1.4–7.69)
3 months to <5 months	4 (10) 40%	5 (37) 13.5%	4.27 (0.52–35.25)
5 months to <15 months	5 (41) 12%	10 (171) 6%	2.24 (0.72–6.96)
15 months to 2 years	36 (93) 39%	24 (115) 21%	2.46 (1.39–4.36)
All age groups combined	46 (153) 30%	40 (328) 12%	3.1 (1.87–5.14)

[a] An incomplete immunization is one not received by the due date of the New Zealand schedule: 6 weeks, 3, 5 and 15 months of age.

encounter with staff and further attention to both provider education and motivational factors. Reducing MOs should be implemented as a quality measure at the practice level.

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Declaration

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Ethical approval: Ethics approval was obtained from the Ministry of Health Regional Ethics Committee to complete an audit of primary care practices.
Conflicts of interest: none.

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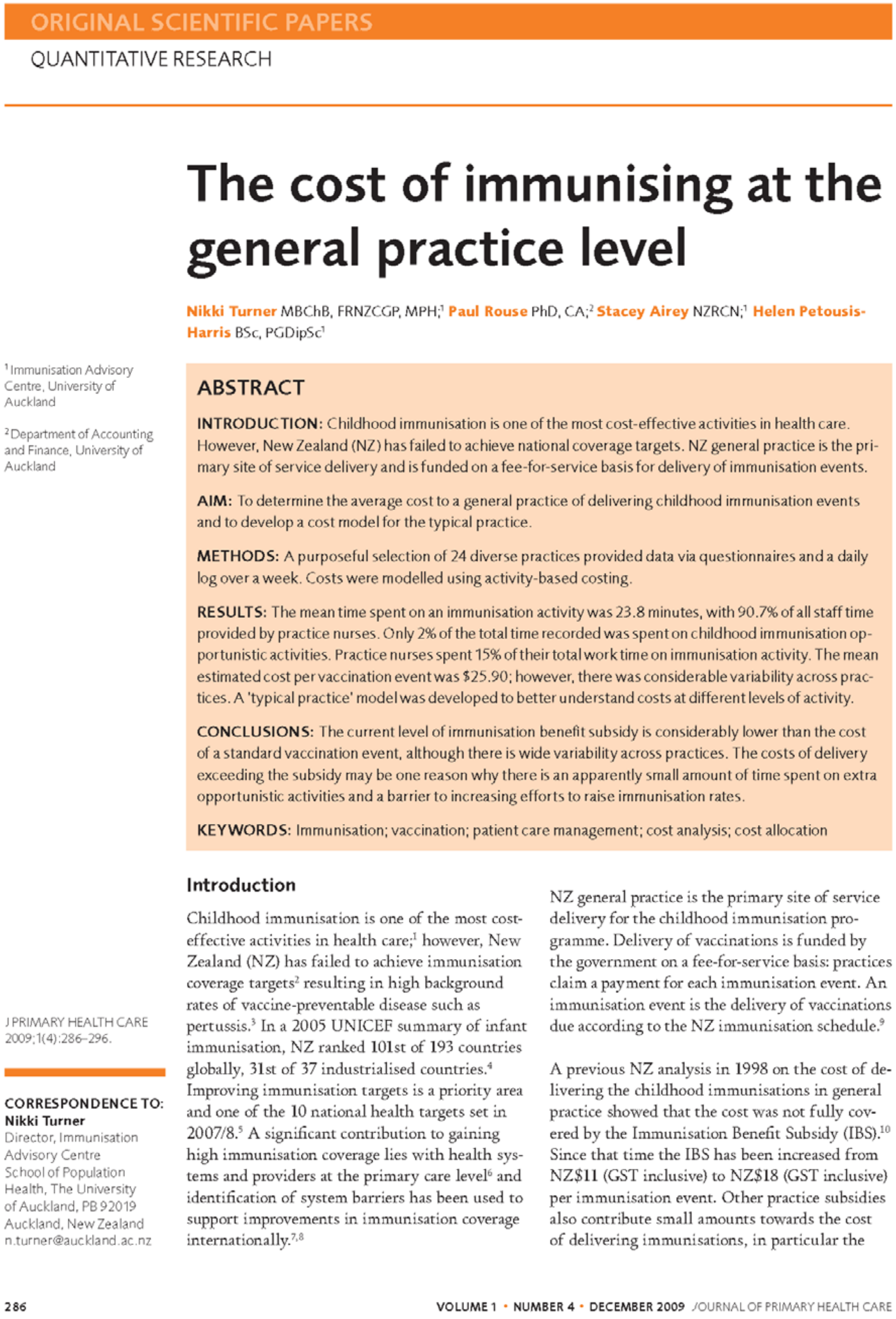

ORIGINAL SCIENTIFIC PAPERS

QUANTITATIVE RESEARCH

The cost of immunising at the general practice level

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ABSTRACT

INTRODUCTION: Childhood immunisation is one of the most cost-effective activities in health care. However, New Zealand (NZ) has failed to achieve national coverage targets. NZ general practice is the primary site of service delivery and is funded on a fee-for-service basis for delivery of immunisation events.

AIM: To determine the average cost to a general practice of delivering childhood immunisation events and to develop a cost model for the typical practice.

METHODS: A purposeful selection of 24 diverse practices provided data via questionnaires and a daily log over a week. Costs were modelled using activity-based costing.

RESULTS: The mean time spent on an immunisation activity was 23.8 minutes, with 90.7% of all staff time provided by practice nurses. Only 2% of the total time recorded was spent on childhood immunisation opportunistic activities. Practice nurses spent 15% of their total work time on immunisation activity. The mean estimated cost per vaccination event was $25.90; however, there was considerable variability across practices. A 'typical practice' model was developed to better understand costs at different levels of activity.

CONCLUSIONS: The current level of immunisation benefit subsidy is considerably lower than the cost of a standard vaccination event, although there is wide variability across practices. The costs of delivery exceeding the subsidy may be one reason why there is an apparently small amount of time spent on extra opportunistic activities and a barrier to increasing efforts to raise immunisation rates.

KEYWORDS: Immunisation; vaccination; patient care management; cost analysis; cost allocation

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Introduction

Childhood immunisation is one of the most cost-effective activities in health care;[1] however, New Zealand (NZ) has failed to achieve immunisation coverage targets[2] resulting in high background rates of vaccine-preventable disease such as pertussis.[3] In a 2005 UNICEF summary of infant immunisation, NZ ranked 101st of 193 countries globally, 31st of 37 industrialised countries.[4] Improving immunisation targets is a priority area and one of the 10 national health targets set in 2007/8.[5] A significant contribution to gaining high immunisation coverage lies with health systems and providers at the primary care level[6] and identification of system barriers has been used to support improvements in immunisation coverage internationally.[7,8]

NZ general practice is the primary site of service delivery for the childhood immunisation programme. Delivery of vaccinations is funded by the government on a fee-for-service basis: practices claim a payment for each immunisation event. An immunisation event is the delivery of vaccinations due according to the NZ immunisation schedule.[9]

A previous NZ analysis in 1998 on the cost of delivering the childhood immunisations in general practice showed that the cost was not fully covered by the Immunisation Benefit Subsidy (IBS).[10] Since that time the IBS has been increased from NZ$11 (GST inclusive) to NZ$18 (GST inclusive) per immunisation event. Other practice subsidies also contribute small amounts towards the cost of delivering immunisations, in particular the historic practice nurse subsidy which is now part of the capitated funding and Primary Health Organisation performance indicators. However, as these funds are not allocated specifically towards immunisation service delivery, it is not currently possible to ascertain what percentage of these subsidies may also contribute towards immunisation service delivery.

It is unknown if the current subsidy is adequate reimbursement to cover the costs of immunising the childhood population of a practice, particularly the extra costs required to increase immunisation coverage through additional efforts in recalling and tracking children.

This study aimed to evaluate the actual cost to a general practice of calling, recalling and immunising children aged 0–5 with the NZ immunisation schedule vaccines.[9] The objectives were to:

- Determine the average cost to a general practice of carrying out childhood immunisations for the national immunisation schedule for their enrolled children.
- Develop a cost model following an activity-based costing approach.
- Evaluate the time commitment at the practice required to deliver schedule childhood vaccines.
- Compare whether costs vary with different practices' settings in terms of geographic, ethnic and socioeconomic factors.

The study is primarily from a micro-financial perspective as opposed to a societal perspective given the above objectives, i.e. to calculate the financial cost to a general practice for carrying out vaccinations. The social cost of immunisations (e.g. costs of low uptake and costs of vaccination reactions) would indicate a macro view compared to the micro focus of this study on individual general practices.

Methods

A pragmatic purposeful selection of practices was undertaken, chosen for diversity in size, socioeconomic mix, geography and practice management style. Data to match the practice socioeconomic mix was undertaken using the NZ Deprivation scale obtained from Statistics NZ website based on 2006 census meshblocks and matched to the corresponding practices' addresses. Selection and recruitment of practices was achieved using the databases and local knowledge of the Immunisation Advisory Centre and networks. Invitations to participate were issued via the national immunisation networks and the GP electronic news.

Five separate data collection tools were developed with feedback from key stakeholder groups, including GPs, practice managers and practice nurses, and pre-tested in three practices. These comprised:

- A financial and total practice time questionnaire (FTPTQ), which included major practice overheads and those specifically relating to immunisation, together with the total hours worked by all practice staff. All practices completed one of these.
- An estimate of GP total immunisation time involvement over an average week. All GPs in the practice completed these.
- A five-day log of time per activity, completed daily over five consecutive days of their choosing by all staff members involved in any of the tasks related to immunisation service delivery.
- A questionnaire covering the less common and monthly events completed as a one-off by all staff involved in immunisation tasks.

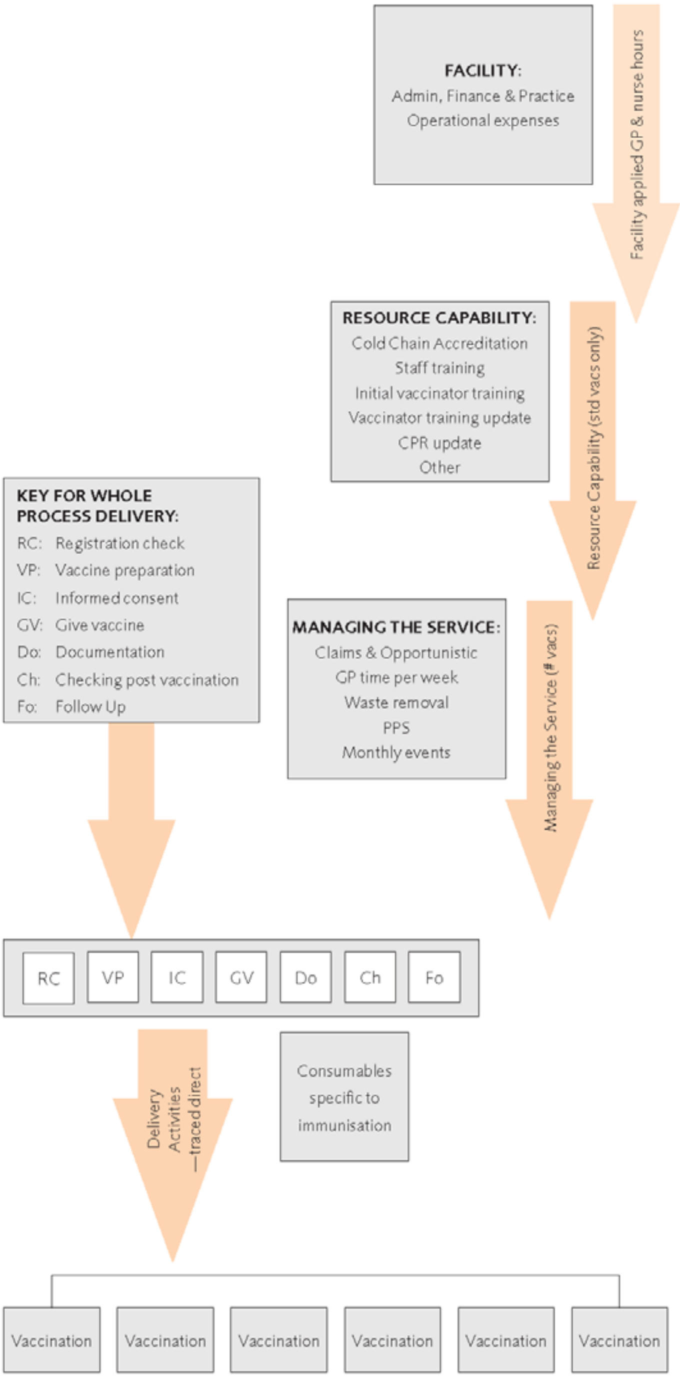
A research nurse contacted and liaised with practices. Based on the understanding of the activities involved in the process, a cost model was developed in which the main immunisation-related activities were identified and traced to vaccination events via measurements of both resources and activities. The research used activity-based costing (ABC) promulgated by Cooper and Kaplan[11] which is now the accepted method for costing in the cost management literature. ABC focuses

WHAT GAP THIS FILLS

What we already know: There is little published data on the components of cost for delivering infant vaccination events at the primary health care level. It is currently unknown in New Zealand if the historical funding of vaccine delivery adequately reimburses the cost of delivering the events.

What this study adds: This study uses an activity-based costing approach to develop a model for viewing all components of the cost of delivering childhood immunisations, as well as providing a cost model for the 'typical' practice.

Figure 1. The cost model hierarchy



on activities and resources consumed which are traced to cost objects using activity cost drivers. These drivers can be classified into a four-level hierarchy that depicts different cost behaviour at different levels. Figure 1 describes these levels in the vaccination setting.

1. **Unit level (vaccination delivery-based):** Activities directly associated with vaccination delivery are registration check (including National Immunisation Register details when needed), vaccine preparation, informed consent, giving the vaccine, documentation, checking the child post-vaccination, and follow-up (see Figure 1). These tend to be sequential for each event. In addition to the cost of these activities, there is the cost of consumables specific to immunisations, such as needles, syringes, plasters, distractions. These costs are classified as unit as they vary directly with the number of vaccinations delivered.
2. **Batch level (managing the service):** These are activities that are required to provide the service, but that do not vary directly with the number of vaccinations given; however they are more time related, e.g. ordering vaccines, claiming, precall, recall and audit procedures.
3. **Product-sustaining level (resource capability):** These are activities associated with providing service capability, not directly affected by the batch or unit levels, e.g. cold chain accreditation and staff training costs.
4. **Facility level:** These are practice level costs/activities that are required to meet infrastructure and/or organisational requirements to facilitate immunisation provisions, but are not directly traceable to immunisation activities per se, e.g. administration such as rent, utilities, insurance, depreciation, financing costs, marketing, operational expenses, waste removal and support staff.

Costs are reported for each hierarchy level, enabling each stage to be considered in terms of its impact on vaccination costs. Assumptions used in the development of the cost model are as follows: The log represents a typical week of immunisation in each practice and the number of working days per annum is set at 229 (45.8 weeks). Nurse and GP hours are then annualised using survey data in order to identify the total time spent on vaccination activities; the 17 practices that provided their major overhead expenses exhibit a reasonable overhead profile of the sample; GP hours are weighted three times those of nurses to reflect pay differentials in calculating overhead recovery rates.

Given the diversity in practice time and cost structures, a model of a 'typical practice' was developed where the best estimates at each hierarchy level were used to estimate the costs at each activity hierarchy level. The model can be used to vary volume levels based on different scenarios, to see the overall impact on total cost and its activity level components. It also provides some reference standards for individual activities within the cost hierarchy. These were derived mainly from the median costs of sample practices, but some were estimated based on knowledge of practice procedures, e.g. the costs of claims were estimated in this model assuming an average time of one minute per claim.

Results for the MeNZB™ vaccination being delivered at the time were separated out from the standard immunisation schedule vaccination. As this was a special event vaccination, it was not considered part of the routine programme.

Ethical approval was not required because this methodology is an audit to scope the costs of the practice, and does not involve patients.

Results

Seventy practices in total were approached over the data collection phase of December 2007 to May 2008. Twenty-eight consented (40%), with 24 (34%) fully completing all the data collection (Table 1). All practices provided information at the unit and batch levels with no information for four practices at the product-sustaining level. One-third of the practices surveyed were either unwilling or unable to supply summarised annual overhead costs. The reasons for not participating, or failing to complete, included staff shortages, confidentiality concerns with supplying financial information and practice staff being too busy to complete questionnaires.

At the facility level, overhead recovery rates were determined for the 16 that did supply this information by dividing total overhead expenses by total estimated GP and nurse annual hours. Median overhead recovery rates were $13.5 per nurse hour and $40.4 per GP hour.

Across the sample, the mean number of vaccination events delivered over a 12-month period per practice was 926, with a minimum of 65 and maximum of 4949.

1. Time spent on activities directly associated with the immunisation process (unit level)

These were captured using the summary of the daily logs (Table 2) and summarised in Figure 2. Note that the average time per activity averaged over practices is shown, as well as the averages across the whole sample data. Although the data is variable, we believe the average (mean) over practices is a reasonable estimate, with a closer similarity to the whole sample statistics than the median. There is a wide range across all activities between practices in how time is spent. Overall, the most time is spent on the informed consent process with a mean time of 4.5 minutes and a range for all practices from 1 to 7.7 minutes. There is wide variability across practices (from 1.1 to 8.9 minutes) on the length of time it takes to undertake the registration check with at least one practice experiencing an event of 60 minutes. Figure 2 also shows the difference in time taken for standard vaccines, particularly for preparation, delivery and documentations versus the MeNZB™ vaccine.

2. Time spent dealing with opportunistic immunisation and overdue immunisations

These data were measured in the daily log. Only 14 practices recorded any time at all spent on this activity. The mean time recorded was 45 minutes per month overall (ranging from 12 to 55 minutes over the 25–75% interval). This represents just over 2% of the total time recorded in the daily logs.

There was a considerable practice range in the time spent on chasing up overdue (late) immunisations across practices (refer Table 5) from 2 minutes per month to 960 minutes per month. To estimate this effect, the costs from the practice that took the most time per month were entered into the typical

Table 1. Practices participating in the project by location, deprivation rating, size, type of practice ownership and ethnicity

							Ethnic breakdown of total practice population				
Practice	**Deprivation level ~**	**Practice size ^**	**Town/ city**	**GP hours per patient**	**Nurse hours per patient**	**Salaried or owner/ op**	**European**	**Maori**	**Pacific**	**African**	**Other**
1	3	Large	City	1.1	0.8	S	77%	6%	17%		
2	1	Small*	City	1.2	1.2	O	89%	5%	3%		3%
3**	7	Small*	City	1.5	1.5	S	66%	7%	13%		14%
4	4	Medium	City	0.9	0.7	O	79%				21%
6	9	Large	City	1.2	1	O	71%	7%			2%
8	8	Small	Town	1	1	S	87%	9%			4%
9	4	Large	Town	1	1	O	52%	34%			14%
10	9	Small	Town	1.4	1.2		74%	14%	2%		10%
11	8	Large	Town			S + O	74%	20%	2%		4%
12	8	Large	Town			O	72%	7%			21%
14	8	Large	City	1.7	2.3	S	20%	15%	22%	43%	
15	9	Small*	City			O	81%	8%			11%
16	6	Large	Town	1.2	0.8	O	90%	10%			
17	9	Large	Town	1	0.8	O	63%	37%			
18	10	Small*	City	1.1	0.7	O	25%	19%		49%	10%
19	6	Large	City	0.7	0.9	O	83%	5%			12%
20	2	Medium	City	1.4	0.9	O	86%				14%
21**	9	Small	Town	2.2	5		9%	88%			3%
22	9	Medium	Town			O	78%	10%			11%
23	6	Small	Town								
24	3	Large	City	1	1.2		82%	6%			12%
25	5	Large	Town	0.9	0.7		51%	6%			43%
26	5	Large	City	0	0		64%	20%			16%
28	4	Medium	City	0.7	0.7		80%	7%			13%

* Denotes sole practitioner

** Denotes Maori or Pacific Governance

~ Deprivation based on X data. 1 is least deprived and 10 is most deprived.

^ Small practice <3000 patients; medium practice <5000 patients; large practice > 5000 patients.

City defined as main population areas of Auckland, Hamilton, Wellington, Christchurch and Dunedin

Figure 2. Vaccination sequence for delivery activities unit level

Times shown are medians:

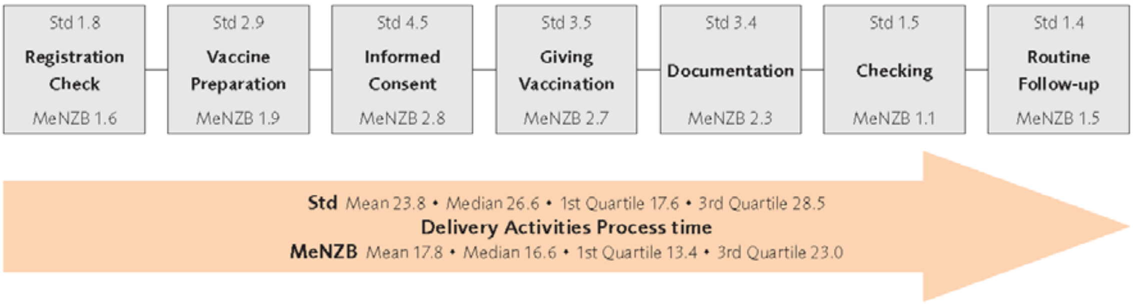


Table 2. Average (mean) times in minutes for activities per event collected in daily log: total times/total events

Average mean times (standard deviation) per event / total monthly times										
Mean time per event/GP	**Reg check**	**Vaccine prep**	**Informed consent**	**Giving vaccines**	**Documentation**	**Checking**	**Routine follow-up**	**Vaccination delivery total**	**Opportunistic**	**Claims**
1	1.2(0.2)	5.8 (2.8)	6.0(2.3)	3.2(2.3)	9.8(10.5)	1.0(0.0)		**26.9**		49.6
2	5.8(2.8)	3.0(0.0)	4.5 (2.6)	7.5(0.0)	3.6(2.8)	8.7(6.0)	2.0(0.9)	**35.1**		22.9
3	1.2(0.3)	11.3(5.3)	7.5(0.0)	7.5(0.0)	3.0(0.0)	1.5(0.0)	1.5(0.0)	**33.4**	11.5	
4	3.0(0.0)	3.4(2.8)	5.0(2.8)	3.6(2.3)	3.5(2.0)	10.5(5.2)		**29.0**	28.6	15.3
6	8.9(8.4)	4.7(3.3)	4.6(2.8)	2.7(1.3)	2.8(1.8)	1.2(0.5)	2.8(0.6)	**27.6**	200.4	53.4
8	1.0(0.0)	3.0(0.0)	7.5(0.0)	6.6(2.0)	4.5(2.3)	1.1(0.2)	1.5(0.0)	**25.2**	32.4	22.9
9	1.8(2.0)	3.0(0.0)	4.8(4.9)	5.3(2.6)	3.6(2.8)	1.5(0.0)	1.0(0.0)	**20.9**	17.2	17.2
10	1.5(0.0)	1.0(0.0)	1.0(0.0)	1.3(0.4)	4.5(4.2)	1.0(0.0)		**10.3**	15.3	11.5
11	1.1(0.2)	1.5(0.4)	7.7(2.3)	1.3(0.5)	3.0(2.3)	1.1(0.2)	1.7(1.6)	**17.5**	11.5	61.1
12	2.6(5.2)	2.6(2.2)	3.9(3.4)	6.6(6.1)	3.3(2.7)	1.9(1.0)	1.8(0.6)	**22.6**		32.4
14	6.1(4.9)	1.6(0.5)	6.1(2.4)	1.5(0.0)	3.3(2.0)	1.0(0.2)	1.0(0.0)	**20.7**	28.6	
15	1.3(0.4)	1.3(0.3)	1.5(0.0)	5.5(3.5)	2.5(0.9)	1.0(0.0)		**13.1**		3.8
16	8.3(13.8)	6.0(5.5)	2.8(0.6)	8.1(4.3)	3.3(2.5)	7.2(4.9)	1.3(0.4)	**37.0**		
17	1.8(0.6)	5.6(2.3)	7.8(4.6)	5.6(3.2)	4.3(2.1)	2.5(0.7)	2.7(1.3)	**30.3**	103.1	154.6
18	1.4(0.2)	7.5(0.0)	7.5(0.0)	7.5(0.0)	4.3(4.6)	1.0(0.0)		**29.1**	63.0	34.4
19	1.5(0.0)	3.1(1.3)	4.4(2.2)	9.5(4.2)	5.6(2.3)	2.1(0.8)	1.5(0.0)	**27.7**		274.8
20	2.4(2.3)	1.8(0.7)	1.2(0.3)	2.4(2.3)	1.9(0.7)	1.9(0.9)	1.0(0.0)	**12.7**		22.9
21	3.9(4.9)	2.4(0.8)	3.2(2.6)	3.5(2.9)	2.6(0.8)	1.0(0.0)	1.0(0.0)	**17.6**	3.8	26.7
22	1.8(0.9)	1.5(0.9)	2.3(2.4)	1.8(1.6)	2.0(2.2)	1.6(0.6)	1.1(0.2)	**12.1**		84.0
23	1.1(0.2)	2.1(0.8)	1.4(0.2)	2.4(0.8)	2.6(0.7)	1.0(0.0)	1.0(0.0)	**11.6**	5.7	45.8
24	2.5(3.5)	2.5(1.5)	3.9(2.5)	2.8(2.3)	4.7(2.3)	8.5(6.4)	3.3(2.0)	**28.3**	84.0	120.2
25	2.4(3.1)	5.0(2.8)	3.8(2.4)	4.2(2.6)	6.7(2.1)	2.3(2.2)	3.7(1.9)	**28.0**	22.9	274.8
26	1.4(0.2)	2.5(0.7)	5.3(3.6)	3.0(1.5)	5.1(2.3)	1.5(0.9)	7.5(0.0)	**26.3**		82.1
28	1.2(0.6)	2.8(1.8)	4.2(3.0)	3.0(1.6)	3.2(1.7)	2.7(4.4)	11.3(5.3)	**28.2**		30.5
Average practice time per event										
Median	1.8	2.9	4.4	3.5	3.4	1.5	1.5	**26.6**	25.8	34.4
Mean	2.7	3.5	4.5	4.4	3.9	2.7	2.6	**23.8**	44.8	68.6
Statistics over whole sample										
Total time	1745.5	829.0	1156.0	1024.0	1174.0	671.0	307.0	**6906.5**	627.8	1438.9
Total events	448.0	256.0	251.0	247.0	285.0	236.0	132.0	**1855.0**	35.0	193.0
Median	1.5	3.0	3.0	3.0	3.0	1.5	1.5	**16.5**	11.5	5.7
Mean	3.9	3.2	4.6	4.1	4.1	2.8	2.3	**25.0**	17.9	7.5
Std Deviation	5.9	2.4	3.2	3.5	3.4	3.7	2.0	**4.1**	16.4	5.4
Maximum	60.0	15.0	15.0	15.0	40.0	15.0	15.0	**85.5**	57.3	28.6
Minimum	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**	3.8	3.8

practice model, which increased the estimated cost per vaccination event from $25.67 to $30.66.

3. Time spent on delivery activities by all personnel

Table 3 shows a breakdown of the activities by staff roles. Overall, the practice nurse's role takes 90.7% of the total time involved in standard immunisation delivery, the receptionist around 8% and the GP around 1% of the time.

Table 4 shows that around 15% of the total work time of a practice nurse is spent on standard immunisation activities (range of 8–22%) and a GP around 0.5% (range 0.2–0.5%) of their total work time.

4. Managing the service activities and cost model

Nineteen practices disclosed the hourly rates paid to staff members, and there was good consistency of results, particularly for practice nurses as measured by the coefficient of variation (CV 0.25). Table 5 summarises the time spent each month for managing service activities, such as vaccine ordering and dealing with late immunisations. The greatest time commitment is chasing up late immunisations (average time of 150 minutes a month) and making appointments (average of 97 minutes a month).

Table 6 summarises the cost at each level across the practices. Overall, the estimated vaccination cost for standard vaccinations is $25.89 with a wide range from $14.38 to $32.50.

5. Analysis of difference in types of practices

Ordinary least squares regression was used to regress vaccination costs at the unit and batch levels against the practice variables of size, deprivation index, different ethnic proportions and urban rural size. No statistically significant relationships were found. However, on a more aggregated level, time spent on delivery activities increased as practice size increased. Mean times and unit cost per vaccination event delivery were 21.9 minutes and $11.32 for small practices (>3000 patients), 22.5 minutes and $11.48 for medium sized practices (>3000–<5000 patients) and 26.9 minutes and $12.80 for large practices (>5000 patients). Managing the service costs also increased with larger sized practices (the main difference being between small practices to medium and large practices); mean costs per annum were $1,953 for small practices, $3,806 for medium sized practices and $3,088 for large practices.

Discussion

Immunisation service delivery follows a natural sequence of activities which have been identified and measured in this study. The activity-based model and its hierarchy allows distinctions to be drawn between patient delivery level and other organisational support levels. Results show that delivery activities are common to every practice and there is considerable variability in times across each activity and across practices.

The activity model provides a structure of common activities and related organisational process

Table 3. Total time in minutes (and % overall) by activity and staff role across all sample practices for standard vaccinations

(Total time from weekly logs)	Admin	Doc	Manager	Nurse	Receptionist	Grand Total
Registration check	3.0 (0.2%)	53.0 (3.0%)	8.0 (0.5%)	1301 (74.5%)	380.5 (21.8%)	1745.5 (100%)
Vaccine preparation				812 (97.9%)	17 (2.1%)	829 (100%)
Informed consent		10 (0.9%)		1146 (99.1%)		1156 (100%)
Giving vaccinations				1024 (100%)		1024 (100%)
Documentation		6.5 (0.6%)	1.0 (0.1%)	1004 (85.5%)	162.5 (13.8%)	1174 (100%)
Checking				671 (100%)		671 (100%)
Routine follow-up				307 (100%)		307 (100%)
Total	3.0 (0.0%)	69.5 (1.0%)	9.0 (0.1%)	6265 (90.7%)	560 (8.1%)	6906.5 (100%)

Table 4. Estimated proportions of total time spent (in hours) by nurse and GPs on immunisation activities per annum (Standard and MeNZB™)

Practice		**Mean**	**Median**	**1st Quartile**	**3rd Quartile**
Annual # of vaccinations		1166	926	497	1544
Time spent on immunisations					
Nurse	**Standard**	588	549	200	794
	MeNZB	203	127	50	301
Total nurse available time		6221	3979	2284	6974
% time on immunisations		15%	12%	8%	22%
GP	**Standard**	21.7	15.3	7.6	37.4
	MeNZB	9.5	7.6	2.0	8.8
Total GP available time		6616.4	5129.6	2713.7	9114.2
% time on immunisations		0.5%	0.2%	0.1%	0.5%

requirements, lending itself to benchmarking and opportunities for practice improvement. This study also developed a 'typical' practice profile with clearly set out assumptions that can (i) provide a reference point for establishing an agreed cost estimate, (ii) be altered with different assumptions, e.g. adding in extra GP time, and (iii) assist in budgeting and planning needs at practice and sector levels.

This is not a random sample and there is a considerable range between practices in costings and time commitment of staff, so the results need to be treated with some caution. While a larger sample size is always preferable, the sample of 24 still provides some important findings. Furthermore, there is diversity of geography, size and socio-economic makeup of these practices.

Overall, the median time taken in the immunisation process was 26.6 minutes (mean 23.8 minutes), range 17.6 to 28.5 minutes. This provides an assessment of how long the immunisation process is routinely taking. The longest time commitment is for the informed consent process (mean of 4.5 minutes), followed by administering the vaccine (3.5 minutes) and documentation (3.4 minutes). The length of time spent in checking registrations has wide variability across practices. This may be due to a range in practice ability and ongoing technical issues around access and use of the National Immunisation Register to check immunisation status. It appears that larger practices spend greater time in delivery activities, particularly registration checks, documentation and follow-up. It is unclear why this may be the case and this result needs to be treated with caution, recognising small sample size.

MeNZB™ data has been presented as a separate item as this was an epidemic vaccine delivery programme that is not part of the standard vaccination programme. It is of interest for future reference for epidemic programme delivery. Standard vaccinations take longer, on average, across all activities and in total than delivery of the MeNZB™ vaccine. This is likely due to the fact that standard vaccinations often consist of more than one injection and informed consent covers multiple diseases and vaccines.

Time spent on opportunistic immunisations is only 2% of the total time recorded in daily logs overall. Although subject to the limitations of the data collection, this finding suggests routine general practice is spending little time on opportunistic efforts to improve immunisation coverage. Recent NZ data has shown that missed opportunities are ubiquitous to NZ general practice and, while recognising parental choice and the constraints in a busy practice, there are a range of systematic ways of attempting to address this.[12] Consideration needs to be given to whether funding constraints are one aspect of why NZ general practice appears to be putting little amount of time into this area. This is an area for further investigation.

Dealing with late immunisations can take a disproportionately large amount of time, as shown by the large range (mean 149.8 minutes, median

Table 5. Time in minutes spent each month on managing the service activities

	Vacc ordering	Audit	Gen appoints	Gen PP rems	Late Imms	PMS	Org ORS	AES adverse events	Total Monthly Minutes
Standard vaccinations									
Mean average time in minutes per month:									
Overall	41.9	13.4	96.8	34.0	149.8	76.1	17.9	12.3	311.0
Nurse	47.4	14.0	109.6	38.7	175.2	74.9	20.0	17.5	425.5
Recep	3.8	15.0	7.5	3.0	0.0	240.0	0.0	0.0	68.0
Standard deviation of time in minutes per month:									
Overall	54.7	11.1	97.1	38.1	240.3	111.6	19.7	16.5	367.8
Nurse	57.4	11.9	97.2	38.9	252.3	111.8	20.1	18.3	380.8
Recep	3.8		10.8						127.4
Median average time in minutes per month:									
Overall	22.5	7.5	60.0	15.0	31.0	31.5	15.0	7.5	181.8
Nurse	25.0	7.5	90.0	30.0	60.0	45.0	15.0	13.1	284.5
Recep	4.0	15.0	1.5	3.0	0.0	240.0			5.8
Number of responses to these questions:									
Overall	27.0	20.0	24.0	15.0	27.0	24.0	17.0	15.0	34.0
Nurse	23.0	17.0	21.0	13.0	23.0	21.0	15.0	10.0	24.0
Recep	3.0	1.0	3.0	1.0	1.0	1.0	1.0	1.0	4.0
MeNZB vaccinations									
Mean average time in minutes:									
Overall	26.1	12.7	104.7	29.4	99.7	50.2	13.4	16.9	228.8
Nurse	29.1	13.5	109.6	33.4	117.1	51.1	15.2	23.8	314.9
Recep	2.8	15.0	1.0	3.0	0.0	120.0	0.0	0.0	36.9
Standard deviation of time in minutes per month:									
Overall	27.6	14.5	96.2	38.2	164.3	49.6	11.4	18.9	260.9
Nurse	28.6	15.6	95.7	39.6	173.4	48.9	11.2	18.8	265.9
Recep	4.1								68.2
Median average time in minutes per month:									
Overall	15.0	7.5	75.0	9.8	33.8	45.0	15.0	15.0	147.5
Nurse	22.5	7.5	90.0	15.0	45.0	45.0	15.0	15.0	244.0
Recep	1.0	15.0	1.0	3.0	0.0	120.0	0.0	0.0	4.3
Number of responses to these questions:									
Overall	26.0	19.0	22.0	15.0	26.0	23.0	15.0	10.0	34.0
Nurse	22.0	16.0	21.0	13.0	22.0	20.0	13.0	7.0	24.0
Recep	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0

31 and skewed distribution), indicating that an individual case can take up a considerable amount of practice time, affecting the overall times and hence workload. If the practice that took the most time on late immunisations was used as an example, this increased time load increases the typical practice model costings by an extra $5 per immunisation event. This suggests that a practice that has to put extra effort into chasing up late immunisation events can incur additional costs up to $5 per vaccination event.

The immunisation process delivery activities are undertaken, in the most part, by practice nurses (91%), with GPs contributing overall around 1.0% of the total staff time spent on immunisations. The practice nurses spend 12–15% of their total nursing time on immunisation delivery activities. This provides an indication of the significant time commitment from practice nurses to immunisation. The estimated cost for a standard vaccination is between $24.50 (median) and $25.89 (mean) with a range from the 1st quartile of

Table 6. Summarised data of the general practice cost profiles for standard vaccinations

	Mean	Median	1st Quartile	3rd Quartile	CV	Typical
Annual # of vaccinations	**1166**	**926**	**497**	**1544**	0.9	1000
Primary activities cost	$ 11.41	$ 12.03	$ 7.91	$ 14.12	0.4	$ 12.03
Consumables	$ 1.34	$ 0.60	$ 0.28	$ 0.84	1.4	$ 0.60
Unit level costs	**$ 12.03**	**$ 12.66**	**$ 7.91**	**$ 15.38**	**0.4**	**$ 12.63**
Claim & opport cost	$ 504.56	$ 283.81	$ 159.05	$ 574.25	1.0	$ 694.98
GP time	$ 2,532.06	$ 1,847.27	$ 604.56	$ 4,408.25	0.9	$ 1,427.43
Removal	$ 122.02	$ 84.60	$ 70.00	$ 150.00	0.6	$ 84.60
PPS	$ 753.49	$ 721.48	$ 400.00	$ 1,095.00	0.7	$ 1,800.00
Other monthly (annualised)	$ 2,629.60	$ 1,960.20	$ 1,066.48	$ 3,545.40	0.8	$ 1,960.20
Batch level (annual cost)	**$ 2,859.41**	**$ 2,237.41**	**$ 1,576.16**	**$ 3,904.97**	**0.8**	**$ 5,967.21**
Cold Chain Accreditation	$ 42.41	$ 27.87	$ 15.11	$ 57.20	1.1	$ 28.60
Staff training	$ 395.97	$ 164.20	$ 74.25	$ 542.91	1.4	$ 164.20
Initial vaccinator training	$ 125.99	$ 137.07	$ 114.03	$ 151.80	0.4	$ 152.53
Vaccinator training update	$ 83.29	$ 57.20	$ 28.60	$ 87.66	1.1	$ 57.20
CPR update	$ 126.61	$ 63.61	$ 32.63	$ 170.78	1.1	$ 63.61
Others	$ 26.35	$ 26.35	$ 19.37	$ 33.33		$ 26.35
Product sustaining level	**$ 563.61**	**$ 382.37**	**$ 251.58**	**$ 711.59**	**1.0**	**$ 492.50**
Overhead–nurse hrs	$ 6,173.54	$ 5,915.61	$ 2,133.82	$ 9,324.99	0.7	$ 5,915.61
Overhead–GP hrs	794.04	659.26	272.26	1,312.68	0.8	659.26
Facility level	**$ 6,729.37**	**$ 6,972.66**	**$ 2,172.22**	**$ 9,495.87**	**0.7**	**$ 6,574.87**
Total costs for # of vaccinations						
Unit level	$ 14,435.91	$ 12,825.66	$ 4,413.78	$ 20,070.60	0.9	$ 12,632.93
Batch level	$ 2,859.41	$ 2,237.41	$ 1,576.16	$ 3,904.97	0.8	$ 5,967.21
Product sustaining level	$ 563.61	$ 382.37	$ 251.58	$ 711.59	1.0	$ 492.50
Facility level	$ 6,729.37	$ 6,972.66	$ 2,172.22	$ 9,495.87	0.7	$ 6,574.87
	$ 17,858.93	$ 15,445.44	$ 6,241.53	$ 24,687.16	1.0	$ 25,667.50
Cost per vaccination	**$ 24.19**	**$ 23.15**	**$ 15.38**	**$ 28.80**	**0.5**	**$ 25.67**
Unit level	$ 12.03	$ 12.66	$ 7.91	$ 15.38	0.4	$ 12.63
Batch level	$ 3.67	$ 2.89	$ 1.48	$ 5.42	0.7	$ 5.97
Product sustaining level	$ 2.08	$ 0.42	$ 0.18	$ 1.78	2.4	$ 0.49
Facility level	$ 8.11	$ 8.52	$ 4.81	$ 9.92	0.6	$ 6.57
Estimated Vaccination Cost	**$ 25.89**	**$ 24.50**	**$ 14.38**	**$ 32.50**		**$ 25.67**

$14.38 to the 3rd quartile $32.50. (Note all these figures are GST exclusive). A significant part of this range in cost is due to variability of delivery activities with a mean $12. Based on these results, the Immunisation Benefit Subsidy (IBS) is not adequately reimbursing general practice for the delivery of routine immunisations. There are other practice subsidies that may contribute extra small amounts towards cost recovery, such as practice nurse subsidies and PHO indicator funding. While these are currently unable to be accurately calculated by the authors, they appear unlikely to cover such a considerable shortfall.

A 'Typical Model' has been developed to better understand costs at the different levels. Based on assumptions of the authors and the data from the survey, the typical model estimates the cost of a standard vaccination to be around $25.67 per vaccination.

NZ continues to have mediocre immunisation coverage rates. This study does not delineate all practice subsidies that may contribute towards immunisation service delivery, but does highlight that the current immunisation benefit subsidy funding, which is the major funder of the immunisation services, is unlikely to provide adequate remuneration to support service delivery at the practice level and hence little incentive towards improving immunisation coverage rates. Furthermore this also may explain why the time commitment for opportunistic vaccination appears to be a low priority at the practice level.

Limitations

Due to the significant time issues involved in data collection, a purposeful, rather than random, selection of practices was undertaken, the sample was small and there was a wide range in results between practices. Hence, these results cannot be taken as representative of the country and need to be seen as an indication, and worthy of consideration, rather than definitive findings.

Conclusions

- The current level of the IBS appears to be significantly lower than the overall estimates of the cost of a standard vaccination event. This could be a significant barrier to increasing focus and effort on immunisation service delivery at the practice level, particularly for the children who may require further effort in recall and follow-up.
- Practice nurses (PN) are the staff with the most involvement in immunisation service delivery in the general practice and spend overall 12–15% of their total time involved in the process of delivery of immunisations. The PN workforce commitment to immunisation delivery is clear from this study.
- GPs spend less than 1% of their total time on delivery of childhood immunisations and hence are likely to be much less engaged in the issues around immunisation service delivery than practice nurses.
- There is considerable variability among practices; some of this may show opportunities for improvement in resource utilisation associated with immunisation service delivery.

Recommendations

The current level of funding for the delivery of the childhood immunisation programme needs to be reviewed. The very low practice time commitment to opportunistic vaccinations needs to be explored further. This may, in part, be related to an inadequate incentive system making the extra time commitment not financially feasible.

The reasons for variability between practices, especially in time taken with registrations, could be explored further, particularly looking at the challenges with accessing and utilizing NIR data.

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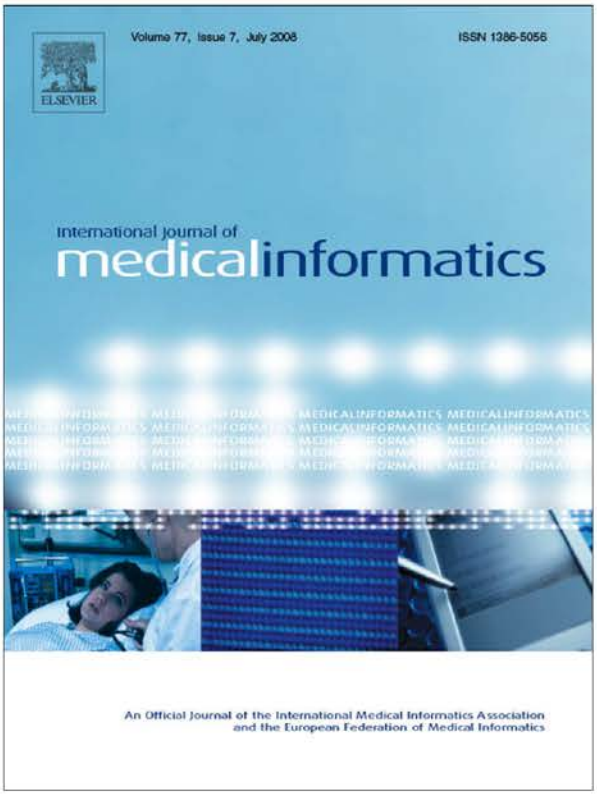
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Determining immunisation coverage rates in primary health care practices: A simple goal but a complex task

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ABSTRACT

Purpose: To explore the quality of data recording by practices and identify issues to be considered and addressed before such data can be used as a continuous measure of immunisation delivery.

Methods: One hundred and twenty-four randomly selected general practices visited to measure immunisation coverage using the various practice management systems (PMS) in use. To capture all target children it was necessary to build two queries: one generated a list of all children aged between 6 weeks and 2 years who had been to the practice, regardless of enrolment status; the other asked dates and nature of all immunisations given. Each different PMS required a unique query to extract the necessary information.

Results: Variability encountered included different types and versions of PMS and operating systems; variable degree of staff technical competence with their PMS; proportion of enrolled children ranging from nearly 0 to 100%; lack of consistency of the nature and location of data entry and coding; and unreliability of dates relating to some vaccination events.

Recommendations: To improve recording of immunisation coverage we recommend a standard early age of registration and enrolment; standard definitions of the denominator and of immunisation delay; greater uniformity of PMS; improved staff training; intrinsic data quality checks; integration of PMS with changes in the immunisation schedule; incentives and interval electronic checks to improve data quality.

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1. Introduction

1.1. *Immunisation coverage and timeliness in New Zealand*

Childhood immunisation is one of the most cost-effective activities in healthcare [1]. In New Zealand (NZ), although immunisation has eliminated polio and controlled tetanus and diphtheria, the full potential benefits to health that immunisation can provide have not been obtained. Measles epidemics continue to occur [2,3]. Pertussis incidence rates are 5–10 time higher than in the UK or the USA [4–6]. Pertussis hospital discharge rates have increased steadily since the 1960s with the average rate in the 2000s (5.8 per 100,000 person-years) being 50% greater than in the 1960s (3.8 per 100,000 person-years) [7].

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The principal reason for this unfulfilled promise is mediocre immunisation coverage and poor on-time delivery of the immunisation schedule.

Regarding coverage, national and regional surveys performed during the 1990s found that less than 60% of children were fully immunised by age 2 years [8,9]. A 2005 national survey showed some improvement but still only 77% of children had received all immunisations scheduled for the first 2 years of life [10].

The available data on the timeliness of immunisation delivery is even more concerning. Timeliness was assessed in the national and regional surveys from the 1990s. Fewer than 60% of children had received all three of the 6 weeks, 3 months, 5 months primary series [8,11] During the 1995–1997 pertussis epidemic delay in receipt of any of the three pertussis vaccine doses scheduled during the first year of life was associated with a five-fold increased risk of hospitalisation with pertussis [12].

1.2. *Immunisation schedule in New Zealand*

The NZ National Immunisation Schedule involves free vaccination for all children at ages 6 weeks, 3, 5 and 15 months, 4 and 11 years for protection against poliomyelitis, pertussis, tetanus, diphtheria, hepatitis B, *Haemophilus influenzae* type b, measles, mumps and rubella [10]. The target is 95% fully immunised by age 2 years [13]. A special immunisation programme for meningococcal B vaccine was also introduced in 2004. Initially a three-dose regime, a 4th dose was licensed in January 2006 for all infants who received their 1st dose before they were 6 months old.

Implementation of the majority of this schedule is conducted in the primary health care setting, chiefly administered by practice nurses and some general practitioners. Practices have kept age/sex registers of their patients for a number of decades, with precall/recall systems universally in place to maximise immunisation coverage. By 2004, 99% of NZ general practices were using a computerised practice management system (PMS) with electronic registration and recall of patients [14]. All major PMS (also known as electronic medical records) in NZ have the ability to collect and audit the immunisations given by the primary health care practice. The majority of practices now actively collect this information as part of their contractual requirements.

In contrast with the mediocre coverage evident in national and regional surveys, some primary care providers achieve much higher coverage rates. Independent practice associations in Christchurch and Rotorua have reported immunisation coverage of over 90% for 2-year-old children enrolled in the practices. Both these examples are from primary health care organisations strongly committed to achieving high immunisation coverage [15,16].

1.3. *Measurement of immunisation delivery in New Zealand using electronic data*

A key factor that has hampered the improvement in coverage has been the lack of any intrinsic mechanism for measuring coverage. The estimates of coverage from 1992, 1996 and 2005 were all from stand-alone separately funded one-off surveys. Attempts have been made to estimate coverage based upon the electronic record of immunisations given. When general practitioners immunise a child, they claim a fee for this immunisation. During the 1990s national immunisation coverage was estimated from these data by dividing the number of claims for a vaccine by the total number of children of the appropriate age group (based upon census population data). Unfortunately several factors invalidate these estimates.

A 1999 review of the current deficits in immunisation surveillance noted that only 53% of general practitioners reported immunisation data electronically. As fee claims for immunisation were not made by some capitated practices, data from these practices were often not entered into the database. The data from some immunisation providers had to be entered manually, some provided summary data only and some did not report any data [17].

Recently a performance management programme was introduced into primary care with additional funding available to practices within many Primary Health Organisations (PHOs) if they improved their performance against targets. The first of the clinical indicators listed is '*children fully vaccinated by their 2nd birthday*' (numerator = total number of children who turned two in the reporting period and had received all immunisations from the National Childhood Immunisation Schedule due at 6 weeks, 3 months, 5 months and 15 months; denominator = number of enrolled 2 year olds as at end of reporting period) [18].

Patients enrolled with a PHO and registered at the practice are included in the PMS report of immunisation coverage. Prior to the implementation of the Primary Health Strategy [19] and the establishment of PHOs, individual practices kept an age/sex register of their patients. Once PHOs were set up, enrolment of a patient at a practice meant that the person enrolling intended to use this PHO provider (general practice or health service) as their normal provider of ongoing primary health care service [20]. People can be enrolled with only one PHO at any one time. Funding for the practice is allocated based on the enrolled population. Individuals seeking services from a provider within a PHO when they are not enrolled with the PHO nor registered with that provider are 'casual users'.

In order to determine whether the recent improvements on the electronic recording of immunisation delivery in primary care have improved immunisation outcomes, we conducted an audit of a random sample of primary care practices. The aim of this study was to explore the quality of data recording by the practices and identify the issues that need to be considered and addressed before such data can be used as a (potentially) continuous measure of immunisation delivery. This study is part of a larger project which sought to determine the contribution that health care system factors make to immunisation coverage in NZ by measuring immunisation coverage in practices, determining the practice characteristics associated with higher immunisation coverage, the associations between health professionals knowledge and attitudes towards immunisation and the immunisation coverage of their patients and the association between parental perceptions of quality of primary care received and immunisation coverage. Reporting the actual details of immunisation coverage is beyond the scope is this current paper.

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2. Method

There were 517 practices available in the study region, 346 in Auckland and 171 in Midland involving approximately 1500 GPs. Two hundred and thirteen of these 517 practices were randomly selected, 108 (31%) of the Auckland practices and 105 (61%) of the Midland practices.

Using random numbers allocated to the complete list of practices in these regions, practices were recruited in random order with a phone call to the principal GP. A random sample of 125 practices, 75 from the Auckland region and 50 from the Midland region with over sampling of Māori practices in both regions was determined to be sufficient size to show statistical significance at the 5% level for a practice characteristic/health professional knowledge measure/quality measure associated with higher immunisation coverage if this characteristic/measure is present in 20–25% more of the practices with higher coverage.

Practices were approached in order of assigned random number, until 125 consented. Seven practices approached were deemed ineligible because they did not have a specific population of children whom they recalled and immunised (for example, a prison clinic). Researcher DY visited each of these practices and worked with staff and the PMS to measure the immunisation coverage. One practice was lost to follow-up (a server crash led to their inability to provide coverage data) leaving 124 recruited practices.

Every New Zealander has a unique identifier for health known as a National Health Index number (NHI). The data required to determine immunisation coverage are the child's NHI, the date of birth of each child cared for by the practice, date of enrolment at the practice, all vaccinations given to each child, the date that each vaccination was given and whether the vaccines were given at this practice or another practice. Use of the NHI number meant that anonymity could be preserved while being able to link children between practices.

The PMS used in the majority of the practices was Medtech-32, but other systems also in use were My Practice (previously called Next Generation and prior to that GPDat), Houston and Profile (for both PC and Mac computers).

At the onset of this project it was assumed that collection of immunisation coverage data would be a simple procedure using the PMS standard immunisation report tool. The requirement was to identify all children under the care of a practice aged ≥6 weeks and ≤2 years, determine all the scheduled vaccinations they had received and the dates when received. While it was recognised that PMS systems differed in their ability to be audited for specific data, it was planned access all types of PMS system in use.

Patients were expected to be easily identifiable through the existing system and each would have a unique identifier, the NHI. It was expected the age/sex register would also include the patient's ethnicity, according to the Statistics NZ definitions, although in reality these data were often absent.

Examination of the standard PMS reports revealed that it was not possible to accurately determine either receipt or timeliness of immunisations. The report merely identified whether a vaccine had been given or not (i.e. whether it was overdue), without the specific date of receipt. A PMS immunisation query therefore could not give information on timeliness of a vaccine, but merely the percentage of children who had received their vaccinations at the time of the date of the report. In some cases it also gave status such as given, declined or non-responder so creating uncertainty as to whether or not the vaccine had been given.

2.1. *Specifically designed queries*

In order to capture all the target children (aged between 6 weeks and 2 years) at a practice, including those who had not received any vaccinations, it was necessary to build two queries. One generated a list of all children aged between 6 weeks and 2 years who had been to the practice, regardless of enrolment status (the patient list), and the other asked the dates and nature of all immunisations given (the immunisation list).

It was therefore necessary to build specific queries for each of the PMS systems in use. There was considerable variation in the assistance received from the various software vendors. In some cases there was reliance on a single GP with the necessary technical knowledge. Some PMS installations (in some cases resulting from local setup issues) demonstrated considerable instability, 'crashing' frequently resulting in the loss of significant amounts of data that had been previously entered electronically.

Using the specific queries built for this project the DY extracted the patient and immunisation information in an anonymised format during a visit to the practice. Results from the patient list and the immunisation list were then merged. The quality of the data extracted from each query varied considerably, with some in a ready-to-use form and others requiring substantial work to generate a single line of data for each child.

A minority of practices are not updated with the latest version of their PMS software hence there were variations across versions of the same PMS as well as between PMSs. Furthermore, the operating system used by the practice can effect how the PMS runs—updated versions may be less compatible with an existing operating system. Because of the variation in information stored and reported on by different versions, each required a unique query (computer programme) to be written to extract the necessary information.

3. Results

We approached 205 randomly selected eligible practices to reach our target population of 125 practices (61% response rate). The main reason given by the 80 practices which declined to participate was time restraint. Many practices were particularly strapped for time because of a contemporaneous staged roll-out of a national meningococcal B vaccination programme. Comparisons were made between the recruited and declined practices using a number of practice characteristics including number of enrolees per practice, and the proportion of practice enrolees that were

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Table 1 – PMS used by practices in the study

PMS	Auckland		Midland		Total	
	n	%	*n*	%	*n*	%
Medtech-32	53	76	42	78	95	77
GPDat/next generation	9	13	2	4	11	9
Profile for Windows	2	3	6	11	8	6
Profile for Mac	5	7	0	0	5	4
Houston	0	0	3	5	3	2
Own system	0	0	1	2	1	1
Paper practice	1	1	0	0	1	1
Total	70	100	54	100	124	100

high needs, were of different ethnic groups and different social deprivation quintiles. No significant differences which might contribute to selection bias of declining practices were detected.

The full range PMS encountered in our study are listed in Table 1. Practice staff seldom demonstrated full technical competence with their PMS system and many available features were not completely understood. The payment required for vendor support may be a barrier to up-skilling staff in this domain.

DY visited all enrolled practices and collected the data. Occasionally more than one visit was required (134 visits were required for 124 practices).

We encountered one practice that did not use a PMS system but relied on a manual age/sex register and paper patient files. The target children were identified manually from the age/sex register, their paper files reviewed and the relevant information entered into a spreadsheet. This was a labour-intensive process, but the data extracted was considered to have a high degree of accuracy.

3.1. *Considerations in query building*

3.1.1. *Patient status*

It was apparent that there are two sets of variables. The first records that the patient is either enrolled or not enrolled. This is recorded at the practice, although strictly it refers to enrolment with a PHO. The other set of variables includes a variety of possible options such as ‘registered’, ‘casual’, ‘visitor’ or ‘transferred’, ‘died’. Only 57% of the children who were registered with a practice were enrolled with the PHO. This complexity was not able to be captured by the PMS audits reports and the specially designed query was necessary to extract appropriate results. This process was both time-consuming and expensive, and particular attention to each practice’s method of enrolment was necessary to ensure data was accurate.

To capture all the target children cared for by the practice, the query had to include registered/not registered; enrolled/not enrolled, and casual/not casual. A huge variation in the proportion of children enrolled was discovered, from near zero to the majority being enrolled.

Different PMS had differing fields in which to enter immunisation data. Most PMS had a pre-determined list, but with the additional ability for practitioners to use free text and to edit the ‘drop-down’ list. This meant that entries such as ‘hepB’, ‘Hep B’ or ‘Hepatitis B’ could all be captured as different vaccines. There was also a lack of consistency as to where specific data was entered. For example there was often a free text ‘notes’ field in which it might be recorded that a specific vaccine was given, the type of needle used, or that a parent had declined a vaccine.

3.1.2. *Unreliability of dates*

In some patient records the date for receipt of vaccination was the same for the entire series—in other words, it might appear that the 6 weeks, 3 months and 5 months vaccines were all given on the same day. On investigation it was found that this was the date of entry, rather than the date the vaccine was given. For example, when a patient enrolled from another practice attended a different clinic, a provider might inform the system that the child’s vaccines were up-to-date, but the actual dates of receiving each vaccine were not entered and probably not even known This is not strictly a data recording error but a system error that requires data transfer from elsewhere, such as from another computer, or at the least requires the PMS system to have an option of ‘given elsewhere’ without reporting a date.

There was also uncertainty around the source of these data—it was typically unclear whether the record that the child had received all vaccinations was based on a report from the mother or other caregiver, or was derived from previous practice records. In some cases, a date might be entered next to a specific vaccination, but this might be the date that the vaccine was declined or the date the vaccine was given—the distinction may or may not be determinable from another coded field or a free text field. In the *NextGeneration* and *Medtech* systems it was clearer to determine when a parent had declined, if this information had been entered. However, in the *NextGeneration* system the decline date could be the same for all immunisations.

Other data-specific issues included earlier dates listed for later immunisations, and dates that were clearly wrong—for example, dates for the MMR vaccine that would suggest that the child had received this during the first 6 months of life. The completeness of the immunisation data for all of the children was listed at each practice. An immunisation was only counted if an immunisation date was listed in the data field for each of the eight immunisation events shown. The percentage of all children for whom immunisations were recorded as given was approximately 70% for the 6 weeks immunisations, 60% for the 3 months immunisations, 55% for the 5 months immunisations and 20% for the 15 months immunisations. There was wide variability across the practices in the proportion of children for whom this data was recorded. This variability was even greater for the immunisations given in the first year of life compared with the 15 months immunisations. Dates were considered invalid if they were prior to the child’s date of birth, the same or later than the date listed for a subsequent immunisation, or if there was no date listed for earlier doses of similar or identical vaccines. The detail of the different types of date data errors is shown in Table 2 along with the 2006 national immunisation schedule.

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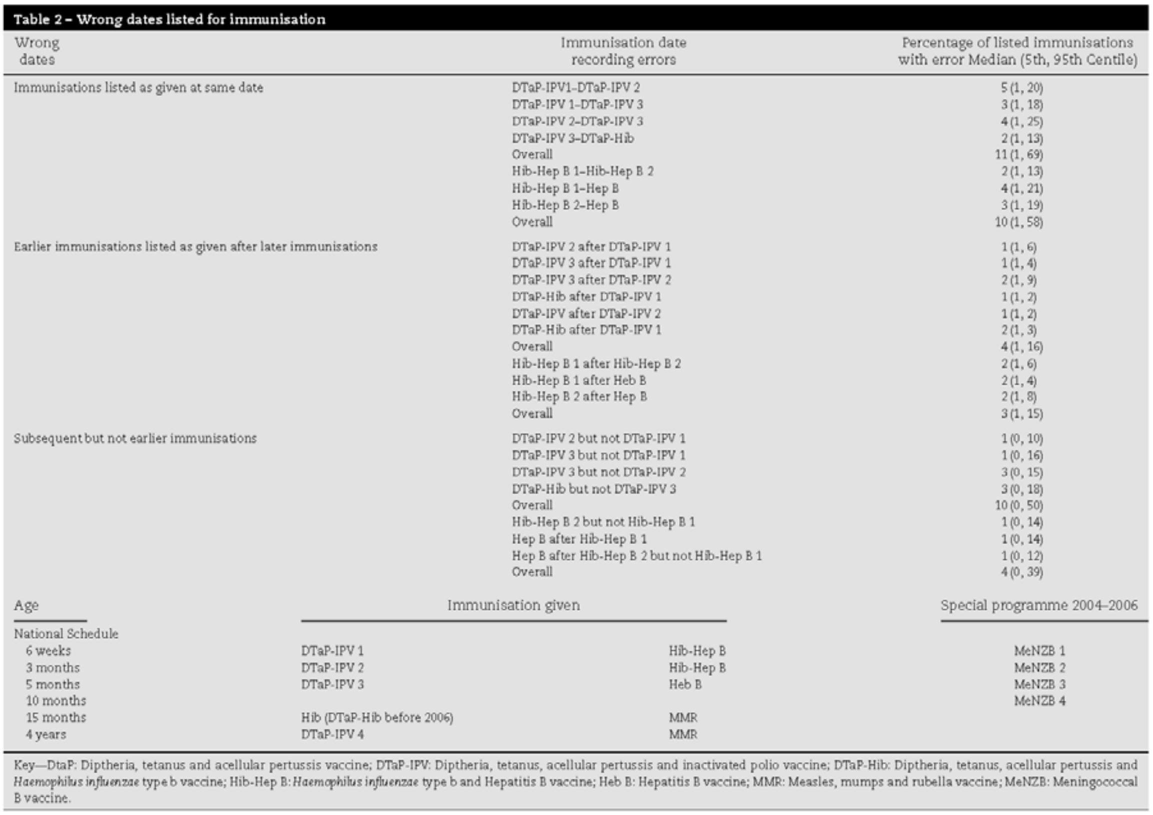

Table 2 – Wrong dates listed for immunisation

Wrong dates	Immunisation date recording errors	Percentage of listed immunisations with error Median (5th, 95th Centile)
Immunisations listed as given at same date	DTaP-IPV1–DTaP-IPV 2	5 (1, 20)
	DTaP-IPV 1–DTaP-IPV 3	3 (1, 18)
	DTaP-IPV 2–DTaP-IPV 3	4 (1, 25)
	DTaP-IPV 3–DTaP-Hib	2 (1, 13)
	Overall	11 (1, 69)
	Hib-Hep B 1–Hib-Hep B 2	2 (1, 13)
	Hib-Hep B 1–Hep B	4 (1, 21)
	Hib-Hep B 2–Hep B	3 (1, 19)
	Overall	10 (1, 58)
Earlier immunisations listed as given after later immunisations	DTaP-IPV 2 after DTaP-IPV 1	1 (1, 6)
	DTaP-IPV 3 after DTaP-IPV 1	1 (1, 4)
	DTaP-IPV 3 after DTaP-IPV 2	2 (1, 9)
	DTaP-Hib after DTaP-IPV 1	1 (1, 2)
	DTaP-IPV after DTaP-IPV 2	1 (1, 2)
	DTaP-Hib after DTaP-IPV 1	2 (1, 3)
	Overall	4 (1, 16)
	Hib-Hep B 1 after Hib-Hep B 2	2 (1, 6)
	Hib-Hep B 1 after Heb B	2 (1, 4)
	Hib-Hep B 2 after Hep B	2 (1, 8)
	Overall	3 (1, 15)
Subsequent but not earlier immunisations	DTaP-IPV 2 but not DTaP-IPV 1	1 (0, 10)
	DTaP-IPV 3 but not DTaP-IPV 1	1 (0, 16)
	DTaP-IPV 3 but not DTaP-IPV 2	3 (0, 15)
	DTaP-Hib but not DTaP-IPV 3	3 (0, 18)
	Overall	10 (0, 50)
	Hib-Hep B 2 but not Hib-Hep B 1	1 (0, 14)
	Hep B after Hib-Hep B 1	1 (0, 14)
	Hep B after Hib-Hep B 2 but not Hib-Hep B 1	1 (0, 12)
	Overall	4 (0, 39)

Age	Immunisation given		Special programme 2004–2006
National Schedule			
6 weeks	DTaP-IPV 1	Hib-Hep B	MeNZB 1
3 months	DTaP-IPV 2	Hib-Hep B	MeNZB 2
5 months	DTaP-IPV 3	Heb B	MeNZB 3
10 months			MeNZB 4
15 months	Hib (DTaP-Hib before 2006)	MMR	
4 years	DTaP-IPV 4	MMR	

Key—DtaP: Diptheria, tetanus and acellular pertussis vaccine; DTaP-IPV: Diptheria, tetanus, acellular pertussis and inactivated polio vaccine; DTaP-Hib: Diptheria, tetanus, acellular pertussis and *Haemophilus influenzae* type b vaccine; Hib-Hep B: *Haemophilus influenzae* type b and Hepatitis B vaccine; Heb B: Hepatitis B vaccine; MMR: Measles, mumps and rubella vaccine; MeNZB: Meningococcal B vaccine.

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Table 3 – Possible Medtech-32 vaccine outcome codes

AG	Alternative given
CIS	Closed not required
CPI	Closed by provider
D	Declined
DEC	Declined elsewhere
DIC	Declined by individual
DMC	Medical contra-indication
DNI	Natural immunity
DPC	Declined by parent
E	Given elsewhere
G	Given
GE	Given elsewhere NZ
GO	Gone overseas
N	Not-given
NR	Non-responder
R	Refused
RE	Re-scheduled

3.1.3. *Establishing whether immunisations had been given*

MedTech-32 has a number of outcome fields for each vaccine (see Table 3) but these were not always accurately entered and different practices used various combinations of these codes. The other PMS systems did not have the same outcome codes. If parents declined vaccines for their children this information was sometimes reported in a 'notes' field but at other times in the body of the (free-text) clinical notes of the child, i.e. uncoded.

Children who had received their first vaccine 'elsewhere' needed to be entered for appropriate recall for their subsequent vaccines. Where all vaccinations have been declined, a practice would sometimes remove this child from the recall list, thus changing either the denominator or numerator, depending on how these numbers were derived.

There is also the issue that the 'non-responder' was handled differently between practices. For example, one practice sent out three recall letters, and then removed the child from the recall system if there has been no response. Another practice followed up non-responders with phone-calls and possible outreach. Children removed from the recall system may or may not still have the 'flag alert' function maintained on their record for possible opportunistic vaccination when they present for other problems.

A small number of children were identified who had actually been immunised although this was not picked up by the PMS query (sometimes because the information was entered in the clinical records part of the notes).

3.1.4. *Inconsistent date of recall*

Recall protocols were not consistent between practices. For example, recalls might be done monthly, three monthly or not at all and might include both children due or nearly due for vaccination as well as those overdue. All PMS have a built in recall system to generate an automatic list of overdue patients. This recall function can be modified by individual providers. Our researcher observed that many practices would rely partly on the PMS and partly on their personalised system for tracking children who were overdue. In addition, some practices relied on PHO data that did not always match with PMS data or would alter the recommended overdue date on their own PMS system. The recommended overdue dates for immunisation, as defined by the Ministry of Health, are the default dates across the PMS recall systems. However, with the ability to alter these dates, guidelines are not always followed.

3.1.5. *Unique identifiers*

Although the NHI number is a unique identifier, it was found that not all patients in a practice had this number entered. Because the extracted data needed to be anonymised, it was important that each patient had a unique identifier. *Medtech-32* generates its own unique number for patients, which can be used as an alternative unique identifier. Multiple and incomplete unique identifiers increase the potential for the same child to appear more than once on any practice patient list or on patient lists from different practices.

3.1.6. *Error analysis*

Once the queries were run at individual practices, considerable error analysis and data cleaning was required. For each practice we generated a merged file that linked the unique identifying data for each child with his or her immunisation record. For our purposes data extracted as one line per vaccination per child needed to be transformed to a single line of information per patient, with a check that the number of vaccines entered added up to the original number from the query data. Because of the variability of codes for specific vaccines, interpretation was required to determine which vaccine had been given. The principal investigator of the overall study (CG) adjudicated, on a case-by-case basis, if a vaccine had been given and, if so, which vaccine and when. Some practices had perfect data sets, some only had a few immunisations categorised as 'other' which needed to be individually determined by CG, and some practices had many in the 'other' category. Table 4 gives an example of data from one practice which required considerable review by CG to determine immunisation status. In this practice 269/2815 (9.5%) of recoded immunisation events were in the 'other' category.

With *Medtech-32*, it could be determined whether a date beside a vaccination event meant that it was given, had been

Table 4 – Example of immunisation data extracted from an individual practice

Vaccine	Number recorded
DTaP-IPV 1	302
DTaP-IPV 2	270
DTaP-IPV 3	227
Hib-Hep B 1	301
Hib-Hep B 2	270
Heb B	213
DTaP-Hib	87
MeNZB 1	294
MeNZB 2	262
MeNZB 3	217
MMR 1	103
Other[a]	269
Total immunisations	2815

Data extracted from practice #373.

[a] Required case-by-case review to determine immunisation status.

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given elsewhere or declined, by checking the outcome codes. This feature was also available on the *NextGeneration* system, but seldom used by the practices. However, with the other PMS, this check was not always possible.

3.2. *Summary of immunisation coverage*

With the analysis limited to those children who are both registered and enrolled a median of 68–75% of children in each practice had received all of the immunisations due according to their age and the immunisation schedule. A median of 45% of children were delayed for at least one of the scheduled immunisations. For both of these measures of immunisation coverage the variance across practices was large.

Only for the 6 weeks and 3 months immunisations received by registered and enrolled children was the median coverage greater than 90% and this was only with the more liberal third dose assumption coverage estimate. With both estimates coverage fell progressively from the 6 weeks through to the 15 months immunisations. A median of approximately 70% of registered and enrolled children 15 months and older had received the 15 months DTaP-Hib and the MMR vaccines. The variance between practices in the proportion of children that had received each immunisation increased with immunisations due at successively older ages.

4. Discussion

This study reports many difficulties in ascertaining seemingly straightforward immunisation coverage data from the usual computerised PMS available in NZ in 2005–2006. With the introduction of PHOs in 2002 [21] came the requirement for patients to be enrolled with only one PHO at any time, usually at the level of the general practice or primary health clinic. The primary health care strategy focus shifted from providing first-line services to restore people's health when they were unwell to including service approaches directed towards improving and maintaining the health of the population [19]. Funding to PHOs is capitated, based on the enrolled population, with greater funding provided to populations seen to be of high need (Māori, Pacific people and those of lower socio-economic status). Patients enrolled with one practice who visit another doctor or health care providers are classified as 'casual' patients and are not required to be included in the immunisation coverage data figures.

The large variation in the proportion of children registered and enrolled largely resulted from an anomaly of the recently introduced capitated (an interesting alternative) funding system. Government subsidies via PHOs are for all enrolled children. Capitated general practices, which receive population-based bulk funding from the government for serving their patients, have to pay a 'clawback' fee when a patient registered with them attends another primary health services provider [22]. This is a significant problem for some practices, especially those with young children being seen by accident and medical or after-hours services, hence some practices chose to not enrol pre-school children because of the financial penalty this could incur.

The data quality issues we identified appear to be due to several factors. Firstly, they illustrate the well-known principle that end-users enter data in a format that may suit them while being quite unsuitable for 'meta-users'. Firstly there is diversity in both the quality of, and expertise in using electronic data management systems. Some of these systems appear to have been developed for alternative purposes, for example billing, and have subsequently been modified to try and also have the capacity to measure immunisation delivery. The variable degree to which each PMS is able to do this introduces errors that are often only apparent to someone familiar with a number of different PMS. Second there is a lack of a quality checking process both within the PMS and within the management of clinic staff entering these immunisation data. Third, despite almost all practices having a PMS, considerable issues persist with the accurate determination of both the denominator and the numerator in any estimate of practice coverage.

Despite these limitations, this electronic data is the only form of immunisation data that has the potential to be used as an intrinsic measure of immunisation delivery. How can this data best be used then? One potential solution to the data quality issues is to generate two estimates of coverage, one that assumes that all immunisation dates listed are correct and the other that excludes data that is of dubious quality.

An example of the first of these assumptions is to state that if the third in a series of vaccine doses is recorded on the PMS, then it is assumed that the previous two doses had been received, whether or not these were recorded. This is known as the 'third dose assumption' [23]. A study of the validity of this assumption in the Australian setting found that accepting the third dose assumption over-estimated coverage by only 0.2%, whereas if the assumption was not used, coverage was under-estimated by 7% [24].

An example of an assumption that is more dependent on data quality is one that requires the date for each immunisation and the date sequence for subsequent doses to both be valid—that is, an immunisation is assumed to have been given if an appropriate date is listed (a date after an earlier dose and before a subsequent dose).

The true coverage is then assumed to be between these upper and lower estimates. In addition to increasing confidence that immunisation coverage is not being over or under-estimated, the variance between these two coverage estimates can also be used as a measure of the quality of the practice immunisation data.

Detailed knowledge of current systems and processes was necessary to establish what seemed a straightforward outcome for this study of immunisation in primary health care. Such detailed scrutiny must be given to this data before it is incorporated in any regional or national immunisation register. The issues identified in this audit are likely to be present in any primary care system where electronic data is stored and reported. The developers of PMS must assume that any opportunity for human error will be made by someone and that reducing the potential for such error must be one of the main drivers for improving the quality of immunisation data and hence of immunisation delivery.

The entire electronic health record environment has developed in an ad hoc fashion. The complexity we encountered

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in what we expected to be a relatively straightforward data collection reflects the lack of common models, systems of categorisation and integration of software design which would enable data interchange between different components of the health care system.

A major influence is the contextual nature of the medical information. Utilisation of health care data for secondary purposes such as research requires disentangling it from the context in which it was produced (in this case clinical encounters) and unless this was actively incorporated in the data collection design, this requires additional work [25]. Where the software is designed specifically for the task at hand, medical data sets can be effective research resources. For example, medical health care software designed to measure the numbers of children fully immunised in Bhorugram, an impoverished remote Indian community with high turn-over of primary health care providers, was able to successfully report an annual increase in immunisation uptake rates, and implementation of the computerised system is likely to have contributed to this improvement [26].

4.1. *Conclusion and recommendations*

On time delivery of scheduled immunisations is an important health outcome, included as one of the 13 health priority objectives in the NZ Health Strategy [27]. The data quality could be improved by defining a national minimum immunisation data set, and mandating its use by contracts with PHOs. Computerised PMS in primary care should enable accurate information about the receipt and timeliness of vaccinations given to our children. Obtaining this information would initially appear to be a straightforward task. However, our experience was that this is a complex and laborious task yielding poor quality data on some occasions.

To improve the situation, we recommend the following:

1. A standard very early age of registration and enrolment: ideally a child should be enrolled with a PHO at birth, but the 6 weeks check-up and first immunisation is also an opportune age.
2. A standard definition of the denominator: Automatic reports of immunisation coverage should include all the children under the care of a particular practice, to ensure an accurate denominator.
3. A standard definition of delay: Standard definitions need to be adopted for what is considered ‘on time’ or delayed vaccination. Where there are a series of vaccines, when the first vaccine has been delayed, the due date for the second or third dose dates should be readjusted accordingly and be considered ‘on time’ if this adjusted schedule is followed.
4. Greater uniformity and reduction in number of different PMS: In particular, the fields capturing immunisation data in PMS should be standardised.
5. Improved training for staff in the use of PMS systems.
6. Intrinsic data quality checks: As much as possible, recording of vaccine information should be menu-driven not free text, to increase the consistency of entered data. There should be only one place in the system where each piece of data can be entered, and dates need to match immunisation or decline events. There should be date range checks to prevent earlier dates entered for subsequent immunisations, the same date given for a series or an inappropriate date recorded for a specific vaccine such as MMR.
7. Changes in the immunisation schedule should result in subsequent updates of all PMS systems in use.
8. An incentive to improve the quality of the data.
9. Interval electronic checks on data quality conducted by the Ministry of Health as part of their data uploads.
10. Standardisation in use of international terminology: For example, Standard Nomenclature of Medicine (SNOMED) clinical terms. This of course also applies to issues other than immunisation.

The accuracy of any future national immunisation register will only be as accurate as the data recorded at practice level. Even with these improvements, the system will still be imperfect—hence the need for the two alternative measures of immunisation which provide more (correct dose and date assumption) and less conservative (third dose assumption) estimates of immunisation coverage.

Electronic PMS can be excellent audit tools, but the axiom ‘rubbish in, rubbish out’ applies. Improving the quality of recorded data enables us to gain greater understanding of the pattern of immunisation coverage of our children. Consistency of the model used by practices would assist—for example defining when a immunisation becomes ‘delayed’ and when recall should be conducted; a common definition of the population of children for whom a practice is responsible

Summary points

What was known before the study?

- Despite a free national immunisation schedule, less than 80% of New Zealand children are fully vaccinated by age 2 years.
- To date in New Zealand there has been a lack of any intrinsic mechanisms for measuring coverage.
- Recent changes to primary care in New Zealand include patient population capitation, electronic immunisation recording and national reporting by general practices.

What the study has added to the body of knowledge?

- Immunisation events electronically recorded at general practice level provide poor quality data for measuring immunisation receipt and timeliness.
- Practice management systems are not designed to generate aggregate data for regional/national/public health monitoring/surveillance and planning.
- Standardisation is required with respect to registration of children with practices, definition of immunisation denominator and delay, electronic entry of immunisation data, and data quality checks.

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and a clear pathway as to the nature and mechanism of immunisation data transfer from practice to practice. PMS can be used for quality assurance and continuous quality improvement but do not easily generate aggregate data for regional, national, and public health monitoring, surveillance and planning.

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ORIGINAL SCIENTIFIC PAPERS
QUANTITATIVE RESEARCH

Early connections: effectiveness of a pre-call intervention to improve immunisation coverage and timeliness

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ABSTRACT

INTRODUCTION: Children who have missed or delayed immunisations are at greater risk of vaccine-preventable diseases and getting their first scheduled dose on time strongly predicts subsequent complete immunisation. Developing a relationship with an infant's parents and general practice staff soon after birth followed by a systematic approach can reduce the number of delayed first immunisations.

AIM: To assess the effectiveness of a general practice–based pre-call intervention to improve immunisation timeliness.

METHODS: Clustered controlled trial of general practices in a large urban district randomised to either delivery of pre-call intervention to all babies at aged four weeks or usual care.

RESULTS: Immunisation timeliness for infants receiving the primary series of immunisations among their nominated Auckland general practices was higher than expected at 98% for the six week event. The intervention was statistically but not clinically significant. Coverage was significantly lower among infants with no nominated practice which reduced overall coverage rate for the district.

DISCUSSION: Pre-call letters with telephone follow-up are simple interventions to introduce into the practice management system and can be easily implemented as usual standard of care. Early identification of newborn infants, primary care engagement and effective systems including tracking of infants not enrolled in general practices has the greatest potential to improve immunisation coverage rates even further.

KEYWORDS: Randomized controlled trial; immunization; vaccination; general practice; intervention studies

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Introduction

New Zealand (NZ) historically has mediocre immunisation coverage of children[1] and relatively high rates of vaccine-preventable disease.[2] The risk of vaccine-preventable diseases is greater if childhood immunisations are incomplete, which includes both missed and delayed immunisations. Delays in immunisation puts infants at significant risk of contracting and being hospitalised for diseases such as *Haemophilus influenzae* type b[3-6] and pertussis[4,6-9] and increases the potential reservoir of disease in unvaccinated infants.[5,10]

Receiving the first dose on the vaccination schedule on time is one of the strongest and most consistent predictors of subsequent complete immunisation[11-13] and delays are significantly more likely to result in lower overall coverage.[12,14-16] In our previous study of 124 practices in the Auckland and Midland regions of NZ, median coverage at six weeks for the diphtheria, tetanus and acellular pertussis immunisation was 93%, while timely receipt of this dose was only 40%.[17]

Factors that impact upon immunisation receipt and timeliness are now well established. These include the knowledge and attitudes of caregivers, particularly antenatally,[18-22] attitudes of health professionals[23,24] and aspects of health care systems such as cost, recall and reminders and cost to provider.[25]

The early establishment of a relationship between general practices and the infant's parents can reduce the number of infants whose first immunisation is delayed.[12] Our prior study demonstrated that early enrolment with a primary care provider was associated with a higher level of immunisation completeness.[17,26,27]

The NZ immunisation schedule from June 2008 for the first six months of life consisted of two combination vaccines: INFANRIX®hexa and Prevenar® given at ages six weeks, three months and five months. INFANRIX®hexa contains antigens from diphtheria, tetanus, and pertussis (DTaP), polio, *Haemophilus influenzae* type b and hepatitis B. Prevenar® (PCV7) is a conjugate pneumococcal vaccine that contains antigens from seven pneumococcal serotypes that are predominant causes of invasive pneumococcal disease.[28] In addition, Bacillus Calmette-Guérin (BCG) is given to infants living in households with people who have, or have had, tuberculosis (TB) or are in immigrant families from countries where TB is common, and HBvaxPRO® (hepatitis B vaccine) is given with hepatitis B–specific immunoglobulin to newborns of mothers who are hepatitis B carriers.

NZ practices typically have recall systems set up in their electronic practice management systems (PMSs) to remind parents that their child's immunisations are overdue. All childhood scheduled immunisations should be recorded on the National Immunisation Register (NIR) at the time of delivery, with data directly transmitted from the practices. The NIR sends reminder messages to practices if information about immunisation events is delayed. The overdue times for NIR are set outside those for the PMS so that the practices have time to follow up before they start receiving overdue messages from the NIR. The PMS will generate a recall for a child at eight weeks if the six week doses have not been given, whereas the NIR will consider that immunisation event overdue when the child is aged 10 weeks. Similarly, PMS and NIR timeliness 'windows' for the three month vaccines are aged four and four and a half months respectively, and again for the five month event aged six and six and a half months.

From our previous work, we hypothesised that the enrolment of children with a general practice soon after birth, and parents being actively invited when their baby is four weeks old to attend the practice for their first (six week) set of vaccines, followed up with early phone calls if they do not respond, would improve immunisation timeliness. We therefore aimed to conduct a randomised controlled trial (RCT) of a general practice–based precall intervention. Our objectives were to assess the effectiveness of this enhanced practice system on coverage and timeliness of the six week, three month and five month immunisations.

Methods

Study design

This was an RCT of a multicomponent intervention compared with usual care. Randomisation was at the level of the general practice. The study was registered with Australia New Zealand Clinical Trials Registry (00082892) and ethical approval was obtained from the Ministry of Health Auckland Regional X Ethics Committee (Reference NTX/08/08/072).

Setting and study population

The setting was practices in the Auckland District Health Board (ADHB) catchment area and the study population was babies born in the ADHB region and/or those whose parents nominated practices in the ADHB region as their general practice. The study took place between 1 November 2008 and 20 April 2010. The NIR is notified of the nominated general practice for all newborns and the practice then is informed by the NIR that they are the baby's nominated practice. Children are tracked using the unique National Health Index (NHI) number assigned at birth.

Intervention

Our intervention consisted of a brief letter of welcome and invitation to attend when the baby was six weeks, plus simple information on immunisation. This was sent by the practice to the baby's caregiver when the baby was four weeks old (see appendix in the web version of this paper for this pre-call material). A follow-up phone call was made to the baby's caregiver when the baby was five weeks old if an appointment had not already been made for the six week vaccinations and, if the caregiver did not present the baby for immunisation, a further attempt at contact (early recall) was made to the caregiver when the baby was seven weeks old. Phone calls were the preferred method of pre-call/recall although a text message, email or letter could also be used. Practices were given a $15 shopping mall voucher per baby to acknowledge the time and effort required to administer the intervention, to be claimed irrespective of whether or not it resulted in immunisation of the baby.

WHAT GAP THIS FILLS

What we already know: Children who have delayed or missed immunisation events are at greater risk of vaccine-preventable diseases. Getting their first scheduled dose on time strongly predicts subsequent complete immunisation, and developing a relationship between the general practice staff and a baby's parents soon after birth can reduce the number of delayed first immunisations.

What this study adds: Immunisation coverage and timeliness for infants receiving the primary series of immunisations among their nominated Auckland general practices is extremely high, with no clinically relevant room for improvement. A pre-call intervention made a statistically significant improvement in timeliness of immunisation, but only by one day. Coverage was significantly lower among infants with no nominated practice and this reduced the overall coverage rate for a district. Targeting both the systems and services that can identify and track infants who are not engaged with primary care at birth has the greatest potential to improve immunisation coverage rates even further.

Inclusion/exclusion criteria and practice allocation

A database of all 148 general practices operating in the ADHB region was created by combining general practice databases held by the Immunisation Advisory Centre and the Department of General Practice and Primary Health Care. Telephone directories were cross-referenced to ensure all practices in the ADHB region were included. All practices were assigned a number (practice code). Practices identified as not involved in delivering infant immunisations were excluded. Following consent, block randomisations were conducted of recruited practices using a computer random number generator to assign each practice to either the intervention or control group. The research team other than the project manager were blind to the identity of practices in the intervention and control groups. Intervention practices were assisted to adjust their PMS to automatically send out pre-call and recall letters to their patients in the study.

Outcome measures

Our primary outcome measure was receipt of six week immunisations and age at which these were delivered as recorded on the NIR for all the babies in our study in intervention, control and non-participating practices. Secondary measurements were receipt of three month and five month immunisations and age at which these were delivered. Pre- and post-trial surveys were also conducted for participating practices to establish their practice population and their pre-call/recall practices before, during and after the trial.

Power calculations

This was a clustered randomised trial with each enrolled practice being a cluster. Because receipt of all three primary series doses is important to most effectively reduce risk of vaccine-preventable diseases, the trial was powered on receipt of three month and five month immunisations. Our previous study had shown that the inflation effect could be between 20 and 40 (see Table 1).[17] A significant contributor to this large inflation effect was the fact that at that time some practices were not enrolling pre-school children in their practices for pragmatic reasons which led to a large inter-practice variability in immunisation timeliness and coverage rates. At the time of this current study, this problem had largely been addressed with the introduction of the NIR plus the introduction of children being fully vaccinated by their second birthday as a performance indicator as part of the Primary Health Organisation Performance Management Programme. With most or all children being enrolled with practices

Table 1. Summary of sample size calculations

Immunisation doses	Timely immunisation coverage			
	Current %	Desired %	Sample size required DE = 20	Sample size required DE = 10
6 weeks	88	98	4000	2000
3 months	75	94	2000	1000
5 months	60	85	2000	1000

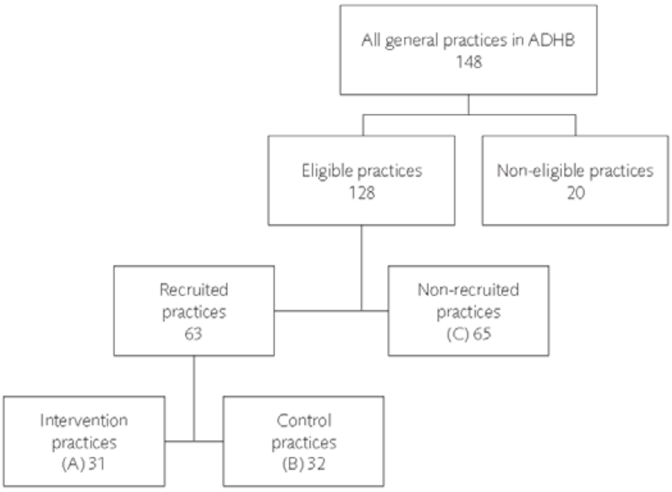
DE = Design effect

soon after birth, the design effect was expected to be significantly smaller. We planned to deliver 1000 interventions. This sample size was calculated to be sufficient to have 80% power at the 0.05 level of statistical significance to detect an increase in the timely immunisation coverage from 75% to 94% at the three month and from 60% to 85% at the five month immunisations.

Analysis

The variables in the NIR dataset consisted of NHI number (converted to a unique identifier), date of birth, dates when six week, three month and five month immunisations given (vaccines coded v1 for INFANRIX® hexa and v2 for Prevenar®), nominated practice at birth, practice(s) giving immunisation for all children born in the ADHB catchment area for the study period (1 November 2008 to 20 April 2010). At this date all intervention babies were aged six months or older. Immunisation events identified as BCG vaccine were deleted.

Figure 1. Recruitment of practices in ADHB

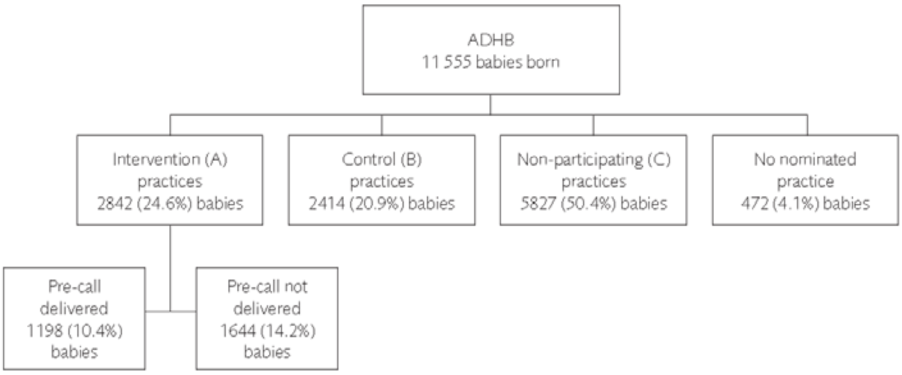


Survival curve analysis was used to measure delay in immunisation. For each infant participant the days from their ideal immunisation date (i.e. 42 days for six week vaccine) to the actual day they received vaccine were counted. For this analysis, second and third dose assumptions were made, i.e. if the three- and/or five month vaccines had been given it was assumed that the child had previously received the earlier doses. We compared total scores (i.e. number of delayed days) using survival analysis (Kaplan-Meier and Cox proportional hazards) for (1) intervention versus control group (intention to treat analysis), (2) pre-call versus non-pre-call in the intervention group, and (3) pre-call in the intervention group versus control group to test if there was any significant differences. This allowed analysis by continuous rather than dichotomous data (i.e. defining an immunisation event as either on time or delayed). This provided greater statistical power and allowed for graphic representation of results plotting number of delayed days over time for both groups. Adjustment for clustering effect was conducted.

Results

Practice recruitment is presented in Figure 1. From 128 eligible practices, 63 were recruited with 31 randomised to the intervention group (A) and 32 to the control group (B). Groups A, B and C (non-recruited practices) were similar with respect to the socioeconomic status of the practice locations and the average practice size. The num-

Figure 2. Babies born in practice groups during the study period


ADHB
11 555 babies born
Intervention (A) practices 2842 (24.6%) babies
Control (B) practices 2414 (20.9%) babies
Non-participating (C) practices 5827 (50.4%) babies
No nominated practice 472 (4.1%) babies
Pre-call delivered 1198 (10.4%) babies
Pre-call not delivered 1644 (14.2%) babies

ber of babies born in the ADHB between 1 November 2008 and 20 April 2010 (a one year 5.75 month period) was 11 555 (see Figure 2). This is 7834 babies per calendar year, which was close to our estimate of 8000 babies per year for the 128 eligible general practices. Half of the eligible practices (63) were enrolled in the study, and close to half (46%) of the babies were nominated to these practices. There were slightly more babies born to the control (B) than the intervention (A) practices. A small number of infants (n=472, 4%) had no nominated practice.

Only 1198 of the 2842 babies in the A practices received pre-call interventions (42%). The reasons for these not being delivered included practices not receiving or being aware of the notification from the NIR in time, practice nurses stopping the intervention for periods of time (for example during the summer period when there were locum nurses), plus one A practice failed to deliver any interventions at all. In many instances details were not recorded as to whether or not the intervention included a five-week pre-call or seven-week recall as well as the four-week pre-call mail-out, so sub-analyses of how often these were required was not possible.

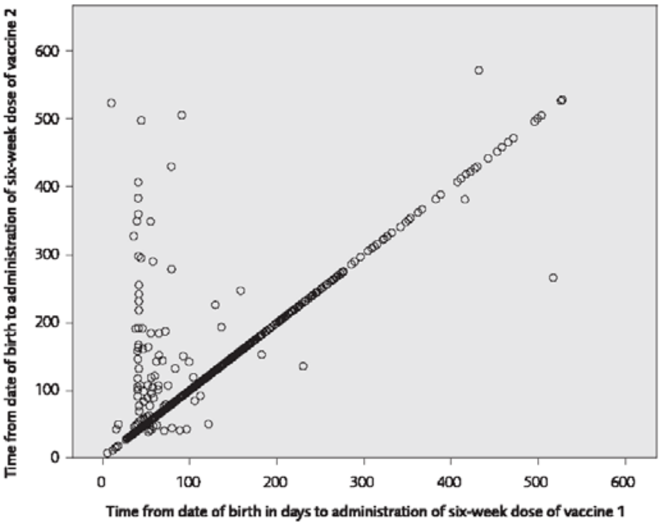
The overall coverage rate for the six week vaccine '1' (INFANRIX® hexa) for A, B and C practices delivered on time by eight weeks of age was 98%—see Table 2. This was also the case for vaccine 2 (Prevenar®). Scatter plots of the difference in timing between v1 and v2 for all cases

Table 2. Overall vaccination rate for six week event for vaccine 1 for intervention, control, non-participating and no nominated practice

Type of practice	Six week vaccine 1 received by age eight weeks	Opted off / Declined	No NIR data	Total	% completed by practice type	% by A, B or C only	% overall
A	2743	53	46	2842	97	98%	94%
B	2388	26	0	2414	99		
C	5744	83	0	5827	99		
D1	32	16	0	48	67		
D2	0	0	424	424	0		
	10 907	**177**	**470**	**11 555**			

Key:
A = Intervention practice
B = Control practice
C = Non-participating practice
D1 = No nominated practice, six week immunisation data available
D2 = No nominated practice, six week immunisation data not available
v1 = INFANRIX® hexa

Figure 3. Differences in timing between vaccines 1 and 2 for six week vaccination event



and then for those in practices A and B showed that these were rarely given separately; hence, separate analyses for v1 and 2 were not required. See Figure 3 for scatter plots for the six week events which shows a straight line when time of delivery of vaccine 1 is plotted against time of delivery of vaccine 2.

When the 472 children with no nominated practice (D) were included in the total, the overall vaccination rate completed by eight weeks of age for the six week vaccination dropped from 98% to 94%. Table 3 shows the average age of receipt of INFANRIX® hexa at six weeks, three months and five months by practice type for children receiving immunisations. It can be seen that non-participating practices (C) consistently had a slightly longer average delay than recruited practices (A and B), but children without a nominated practice who were vaccinated had a much greater average delay. While the majority (88%) of the babies attended the practice their parents nominated at birth, 12% were either vaccinated or declined vaccination at a different practice for vaccine 1 at the six week event.

We analysed data both using the second and third dose assumptions (e.g. if the three month dose was recorded in the NIR, we assumed the six week event had been given) and not making this assumption but categorising these children as having no information on the six week vaccination event. This made a slight difference in coverage rates. When applied to immunisation registers, the third-dose assumption results in an over-estimate of immunisation coverage that is smaller than the underestimate produced by assuming all those with missing data have not been immunised.[29]

When the vaccination times of A and B practices for receipt of the six week vaccine were compared (intention-to-treat analysis), there was no indication of a difference between the groups (Log Rank (Mantel-Cox): Chi-square 0.268, df=1, *p*=0.605). There also was no difference in days to vaccination for the three month vaccine event (Log Rank (Mantel-Cox): Chi-square 0.540, df=1, *p*=0.46) nor for the five month vaccine (Log Rank (Mantel-Cox): Chi-square 0.281, df=1, *p*=0.60).

Table 3. Average age of receipt of INFANRIX® hexa at six weeks, three months and five months by practice type

Practice type	Average age in weeks of receiving six week v1	Average age in months of receiving three month v1	Average age in months of receiving five month v1
A	7.06	3.40	5.64
B	7.09	3.43	5.65
C	7.26	3.48	5.7
D	8.92	4.49	6.32

Key:
A = Intervention practice
B = Control practice
C = Non-participating practice
D = No nominated practice
v1 = INFANRIX® hexa

However, this analysis did not take into consideration the fact that the 58% of children in the A practices did not receive the intervention.

We therefore conducted a second analysis looking at vaccination in group A, stratifying by actual delivery of the intervention. This showed that babies receiving the intervention were statistically more likely to receive their six week vaccination event earlier (Log Rank (Mantel-Cox): Chi-square 19.187, df=1, $p<0.001$) with mean days to six week vaccination event 49.6 days for those who received interventions compared with 51.2 days for those who did not—see Figure 4. An advantage of this analysis is that it takes into account types of censored data, for example where six week data is missing but the third dose assumption is used. The same pattern was repeated for vaccination coverage stratified by delivery of intervention for A practices for the three month vaccination event (Log Rank (Mantel-Cox): Chi-square 16.527, df=1, $p<0.001$) with mean days 100.1 compared with 103.8, and for the five month event (Log Rank (Mantel-Cox): Chi-square 11.621, df=1, $p=0.001$) with mean days 166.2 compared with 170.1.

A third analysis comparing only those babies in the A practices who had received the intervention with the group B babies found a similarly significant result for the six week vaccination event results (Log Rank (Mantel-Cox): Chi-square 5.969, df=1, $p=0.015$), the three month (Log Rank (Mantel-Cox): Chi-square 10.722, df=1, $p=0.001$) and the five month (Log Rank (Mantel-Cox): Chi-square 6.753, df=1, $p=0.009$).

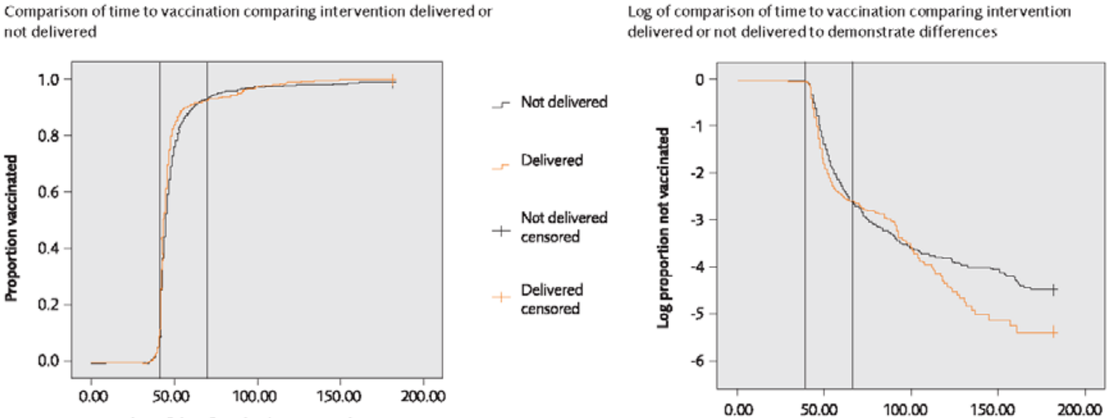
While there was no statistical difference in timeliness between A and B groups, we expected that recruited practices (A and B) would have less delay in immunisation overall than C practices which declined to participate (and may be less focused on vaccination). We therefore repeated the timeliness analysis including group C for the six week vaccine. We found that group C practices had a significantly more delayed vaccine rate for the six week vaccine (Log Rank (Mantel-Cox): Chi-square 14.705, df=1, $p=0.001$).

Lastly, analysis of practice surveys found that 13 A and 12 B practices used some form of pre-call prior to the trial. All but one A practice (which had failed to use the pre-call intervention) intended to continue using our pre-call intervention post-trial.

Discussion

At the commencement of our study in 2008, NZ immunisation rates were estimated from the NIR data to be 88% for the six week vaccine event, 75% for the three month event and 60% for the

Figure 4. Days to six week vaccination event in Group A stratifying by actual delivery of the intervention



The window for 'timely' six week vaccination is 6–10 weeks (42–70 days) five month event. We calculated our sample size based on these data. However, we found the coverage rate for enrolled children in all practices in the study was much higher than expected, at 98% for the six week vaccine and dropped off very little for the three month and five month doses.

We did find a statistically significant improvement in timeliness of vaccine receipt at the six week, three month and five month events comparing children who received the intervention with those who had not, but because the coverage rates were so high, this only translated into children receiving the vaccine on average one day earlier (from 49.5 days to 50.5 days for the vaccine due at 42 days), which is not clinically significant.

Given that there were much higher coverage rates across all practices to start with, the lack of clinical significance is not surprising.

While the average coverage among all the ADHB practices was 98%, there was a small percentage of infants without nominated practices (n=472, 4%). Thirty-three percent of infants with no nominated practice for whom there was an entry for the six week vaccination event were not vaccinated. When these infants were added to the total, the overall coverage rate dropped to 94%. This is an important finding. Infants with no nominated general practices are much less likely to get immunised and, if they do, are much more likely to be delayed. This reduces the overall coverage rate significantly for the region (making the general practices look as though they are performing less well than they are). Children who are not getting general practice services including immunisation pre-call and/or recall can be considered to be 'falling through the cracks': Attention needs to be given to this group of children, both encouraging earlier general practice enrolment for them and targeting outreach services for those unenrolled.

We identified a number of places where errors occur in the collection of data in the NIR: the practitioner (usually the practice nurse) may enter incorrect data in the PMS, there may be technical problems with the transfer of data from the PMS to the NIR, the NIR might send back error messages to the practitioners' inboxes that they do not know how to action, a practitioner may not know how to manage entry of complex 'catch-up' schedules when a child is presenting late or has received a different immunisation regime in another country, or the PMS might not have the facility to record these complex immunisation entries accurately. An unvaccinated child presenting at three months may have this immunisation event recorded as the three month rather than the six week vaccination event. Furthermore when patients transfer practices it is usually not possible for their full clinical records to be transferred electronically between practices. This means that the new practice needs to manually enter previous vaccines from paper records or the child well health book, which will not always be available.

How our findings relate to what is already known

Timeliness of children's vaccination varies widely between and within countries.[30-39] There are a range of factors associated with timeliness reported in these studies. Ethnicity, area of residence[21,40,41] and negative media coverage are all associated with delay in vaccination.[36]

Integrated systems including outreach and recall has been shown to be effective. For example, an extensive programme in Chicago which combined immunisation education at birth with ongoing reminder–recall achieved over 90% on-time adherence for recommended immunisations among inner-city children aged 0–35 months.[42] Having a nurse vaccine manager who is in charge of tracking inventory, training staff, and developing vaccination protocols can improve timeliness of vaccine delivery.[43]

Our study shows that enrolment and early engagement with a general practice is resulting in excellent coverage and timeliness. However the children not enrolled with a general practice fare poorly and represent a small but significant group for whom outreach services should be targeted, and assistance given for the infant to join a general practice.

Strengths and limitations

We piloted the intervention set-up, received early datasets for testing, performed dummy runs, double-entered data and performed meticulous data cleaning to ensure we had an accurate dataset to analyse.

However, we recruited fewer practices to the study (63/128, 50%) than the 60% we had intended and we had delays in some practices implementing the intervention. The intervention was only delivered to 42% of the eligible children in the intervention practices, plus some of the practices reported that they were already doing some form of recall; hence, the comparison between intervention and control group had no significant difference. We had incomplete records of whether or not the delivered intervention included five-week pre-call or seven-week recall contacts.

Recommendations

As a result of this study we recommend that NIR notify general practices so that they are aware of all newborns for whom the practice is the nominated provider as soon as possible after birth, and that DHBs follow up newborns with no nominated providers to ensure registration with a provider as early as possible. Different regions will use different strategies to achieve this. We further recommend that practices send a pre-call letter with accompanying information about immunisation when infants are aged four weeks, as a fully automated prompt system followed by telephone contact if the family does not make contact seems to be a cost-efficient and sensible strategy. Because many Auckland practices are already doing some form of pre-call, having a standardised four-week pre-call letter prompt system that all practices could use may have a positive effect on timeliness. It could assist those practices who are not pre-calling and act as a reaffirmation to those practices who are pre-calling that their current commitment is worthy of continuing.

Conclusion

We found immunisation coverage and timeliness for infants receiving the primary series of immunisations among their nominated Auckland general practices to be extremely high, with no clinically relevant room for significant improvement. The intervention trialled in this study made a statistically significant improvement to timeliness of vaccination; however, only by one day. However, coverage was significantly lower among infants with no nominated practice and this reduced the overall coverage rate. Non-enrolment of babies at birth with a general practice is a significant factor in delayed or missed immunisations. Targeting both the systems and services that can identify and track these infants has the greatest potential to improve immunisation coverage rates even further.

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COMPETING INTERESTS

None declared.

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APPENDIX A: Pre-call material

A pre-call letter and information sheet about immunisation was generated by the PMS for four-week-old babies. These were printed on white A5 paper using the practice nurse's standard paper and printer.

Pre-call letter

Dear [name of caregiver],

We would like to welcome your new baby to our practice.

As our babies grow, immunisation is part of the regular care that they are offered. It is nearly time for your baby's first immunisations which are due at six weeks of age.

Having your baby immunised on time is important and offers protection against seven serious diseases early on. Enclosed you will find some brief information about the six week immunisations. Scheduled childhood immunisations are free for all New Zealand children.

Please contact us at the practice to arrange a time to come in. We look forward to meeting you and your baby.

Kind Regards,

[Practice contact]

Information about vaccines at six weeks

Getting your baby immunised on time at six weeks will reduce the chance of contracting vaccine-preventable diseases. Starting on time is important because young babies are particularly at risk of catching these diseases.

At six weeks, two injections are offered to provide protection against seven serious diseases. One injection called INFANRIX® hexa and one called Prevenar® start the important process of protecting your baby against diphtheria, tetanus, whooping cough (pertussis), polio, hepatitis B, *Haemophilius influenzae* type b, meningitis and pneumococcal disease.

As with any health procedure, there are risks and benefits. If you have any questions, please talk with your GP or practice nurse or call 0800 IMMUNE (466863). More detailed information about the immunisations your baby will be offered and the diseases the vaccines protect against can be found at http://www.immune.org.nz/.